Geotechnical Evaluation Report

Cayuga ISD Expansion
17750 North US Highway 287
Bethel, Texas 75861

Prepared for

Cayuga Independent School District

"This draft report is released for the purpose of interim review under the authority of Ramtin Eskandani, PE No. 150756 on July 24, 2024. It is not to be used for construction or final design purposes."

Ramtin Eskandani, PE
Geotechnical Department Manager, Project Engineer
License Number: 150756
July 24, 2024

Project B2405335

Braun Intertec Corporation
TBPELS Firm Registration No. F-12228

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July 24, 2024 Project B2405335

Dr. Joe E. Satterwhite III:
Cayuga Independent School District
17750 North US Highway 287
Bethel, Texas 75861

Re: Geotechnical Evaluation
Cayuga ISD Expansion
17750 North US Highway 287
Bethel, Texas

Dear Dr. Satterwhite III:

We are pleased to present this Geotechnical Evaluation Report for the Cayuga ISD expansions located at the above referenced site.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact us at 903.581.8080, or email Ramtin Eskandani at Reskandani@braunIntertec.com or Cody Wardien at Cwardien@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION
TBPELS Firm Registration No. F-12228

Cody Wardien, PE
Director, Senior Engineer

James Griffith, PG
Field Project Manager

Ramtin Eskandani, PE
Geotechnical Department Manager, Project Engineer

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A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report provides geotechnical findings and recommendations needed for the design and construction of a new addition to the west side of the existing Agricultural Science building, construction of new baseball and softball fields with associated sport lights and grandstands, new asphalt parking with associated light poles, and discus/shot put area. The following Tables provide additional project details.

Table 1. Project Descriptions

	Description / Structures		
Aspect	**Ag Science Building Addition**	**Baseball and Softball Fields**	**Discus/ Shot Put Facility**
Below grade levels	--	--	--
Above grade levels	Single-Story	New grandstand bleachers with a press-box, dugouts, and associated sport lights	Associated light poles
Approximate square footage	6,400	--	
Preliminary Finished Floor/ Grade Elevations	352.70 feet (To match the existing building)	364 feet (Assumed to balance the site)	369 feet (Assumed to balance the site)
Column loads (kips)	60 (Assumed)	Grandstands: 45 (Assumed) Light Poles: 5 (Assumed)	Light Poles: 5 (Assumed)
Wall loads (kips per linear foot)	3 (Assumed)	Grandstands: 3 (Assumed)	--
Nature of construction	Pre-engineered metal building supported over shallow spread footing foundations	▪ Grandstands and press box will be a pre-engineered metal structure supported on shallow spread footing foundations. ▪ High performance grass (synthetic turf) ▪ Associated lights will be supported on drilled shafts	▪ Irrigated grass field ▪ Associated lights will be supported on drilled shafts

<table>
<tr><th rowspan="2">Aspect</th><th colspan="3">Description / Structures</th></tr>
<tr><th>Ag Science Building Addition</th><th>Baseball and Softball Fields</th><th>Discus/ Shot Put Facility</th></tr>
<tr><td>Cuts or fills (Assumed)</td><td>Cuts and fills of less than 1 foot (Based on FFE of 352.70 feet)</td><td>Cuts/fills of up to 4 feet (Baseball field)
Cuts/fills of up to 2 feet (Softball Field)</td><td>Cuts and fills of up to 3 feet</td></tr>
<tr><td>Tolerable movement</td><td>1 inch</td><td colspan="2">1, 1-1/2 and 2 inches</td></tr>
</table>

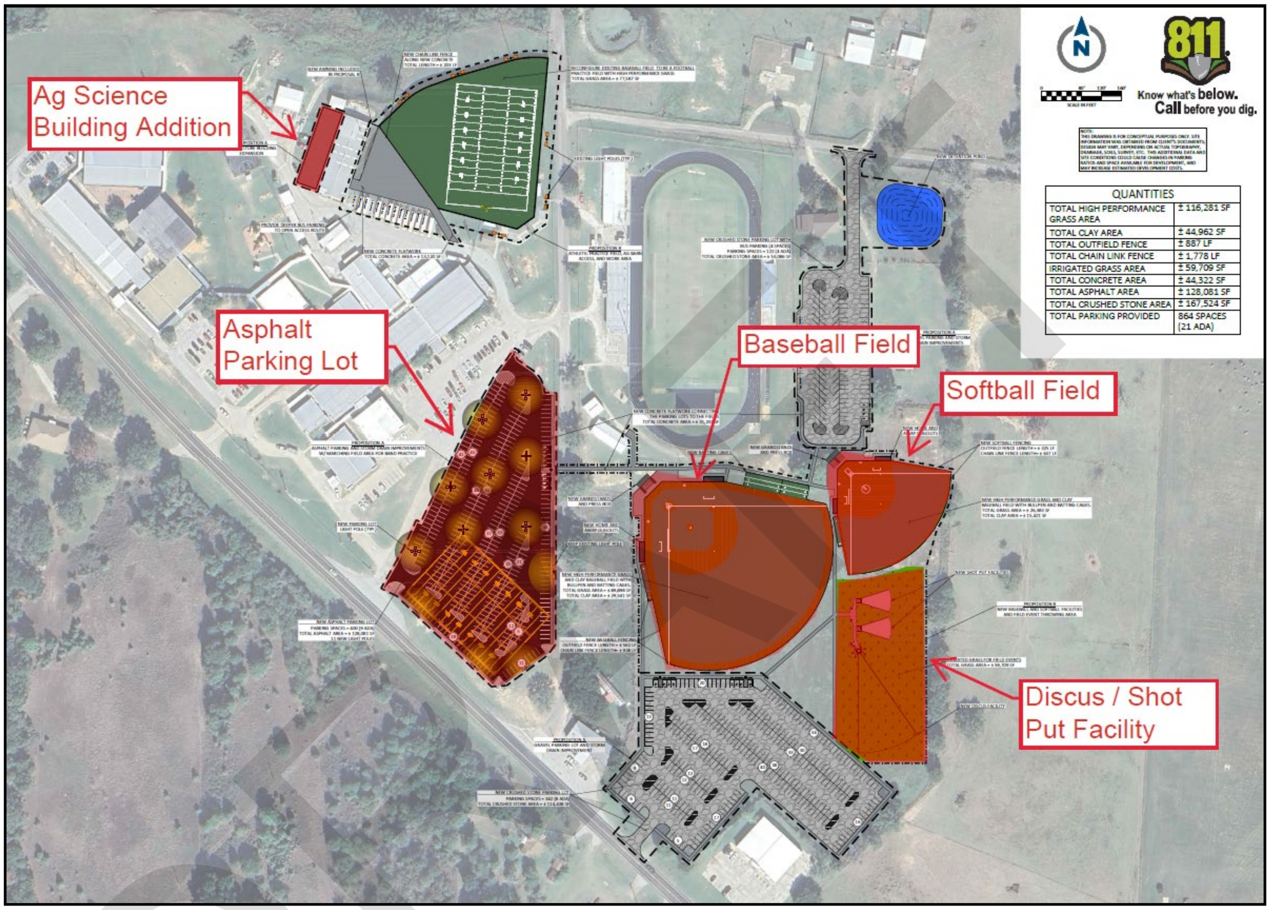
Table 2. Pavement Description

Aspect	Description
Pavement type	Asphalt
Assumed Pavement loads	Light-duty (Automobile traffic): 40,000 ESALs* Medium-duty (Associated drives for buses and fire trucks): 100,000 ESALs
Grade changes	Cuts and fills of less than 2 feet (Assumed)

*Equivalent 18,000-lb single axle loads and is based on a 20-year design life for the pavements.

The following Figure shows an illustration of the proposed site layout with the proposed project locations highlighted in red.

Figure 1. Site Layout



QUANTITIES	
TOTAL HIGH PERFORMANCE GRASS AREA	± 116,281 SF
TOTAL CLAY AREA	± 44,962 SF
TOTAL OUTFIELD FENCE	± 887 LF
TOTAL CHAIN LINK FENCE	± 1,778 LF
IRRIGATED GRASS AREA	± 59,709 SF
TOTAL CONCRETE AREA	± 44,322 SF
TOTAL ASPHALT AREA	± 128,081 SF
TOTAL CRUSHED STONE AREA	± 167,524 SF
TOTAL PARKING PROVIDED	864 SPACES (21 ADA)

Figure prepared by CEI, entitled “Cayuga ISD High School Sports Facility Improvements,” dated March 21, 2024.

A.2. Site Conditions and History

Currently, the project site is part of the existing Cayuga High School campus. The project site is bordered by North US Highway 287 to the southwest, and County Road 4751 to the northeast of the campus. The surrounding area has been developed with a Family Dollar store to the southeast, and residences to the west and east of the campus. The proposed area for the Ag Science Building addition is currently partially paved with asphalt and partially grass covered. The remaining areas of the project site are covered with grass, scattered trees, a pond to the southeast, and an agricultural field to the east. Our review of historical imagery indicates the existing high school, football field, baseball and softball fields were constructed before February 1995. The following Figure provides an aerial image of the site in Google

Earth™ with the proposed structures outlined in red, the new fields outlined in green, and the new paving outlined in blue.

Figure 2. Aerial Photograph of the Site

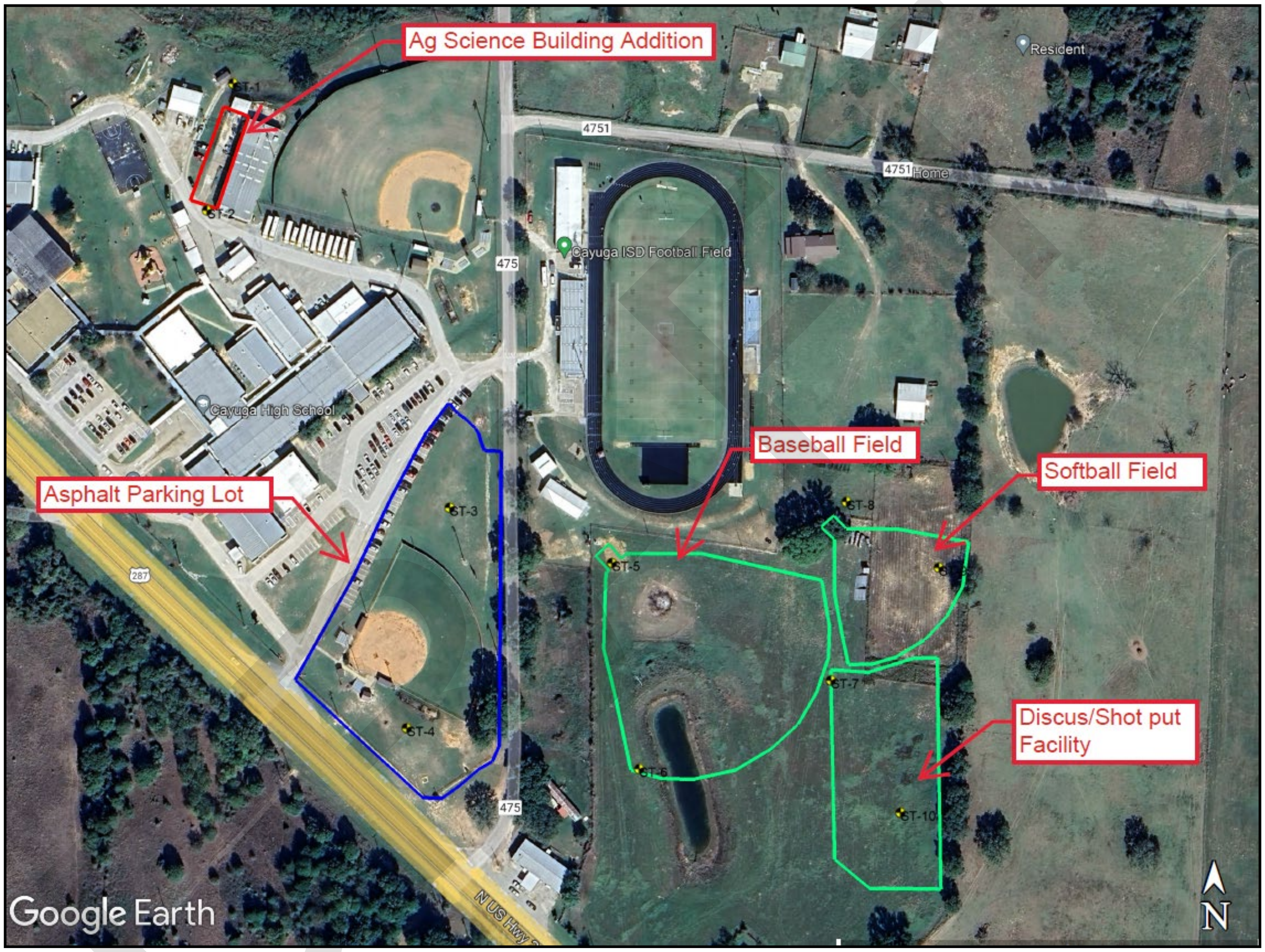


Figure obtained from Google Earth™, imagery date of November 2023.

A.3. Purpose

The purpose of our geotechnical evaluation is to characterize the subsurface geologic conditions at selected exploration locations and evaluate the impact on the proposed project and provide geotechnical recommendations for the design and construction of the proposed project. We will perform our services in accordance with generally accepted engineering practices prevailing at the time and in the geographical area of the project location.

A.4. Background Information and Reference Documents

We reviewed the following information:

- Conceptual site plan rendering provided by CEI, entitled “SITE PLAN,” dated March 21, 2024.
- Floor plan provided by Thompson Architectural Group, Inc, entitled "BLDG 1- Floor Plans”, dated November 13, 2023.
- Communications with CEI and Thompson Architectural Group regarding project details.
- Aerial images of the site viewed in Google Earth™, imagery dates of February 1995 to November 2023.
- Texas Geology Web Explorer (https://txpub.usgs.gov/txgeology/).

In addition to the provided sources, we have used several publicly available sources of information.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses, and/or recommendations.

A.5. Scope of Services

We performed our scope of services for the project in accordance with our proposal to Dr. Satterwhite III with Cayuga Independent School District dated June 3, 2024, authorized on June 10, 2024. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewed the background information and reference documents previously cited.
- Contacted the Texas Call Before You Dig service and notified the participating utilities of our planned exploration locations to avoid damage to underground utilities. The boring locations were staked in the field using a submeter Global Positioning System (GPS) device at locations we selected by overlaying the site plan in Google Earth™ and obtaining coordinates at those locations. Ground surface elevations were also gathered from a submeter GPS device. The

Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings.

- Drilled 10 borings, denoted as ST-01 to ST-10, to nominal depths of 20 to 25 feet below existing grade across the site.

- Performed laboratory testing on selected samples to aid in soil classification and engineering analysis.

- Prepared this report containing a boring location sketch, a fence diagram, logs of soil borings, a summary of the soils observed, results of laboratory tests, and recommendations for structure and playing fields subgrade preparation and the design of foundations, floor slabs, exterior slabs, pavement, and utilities.

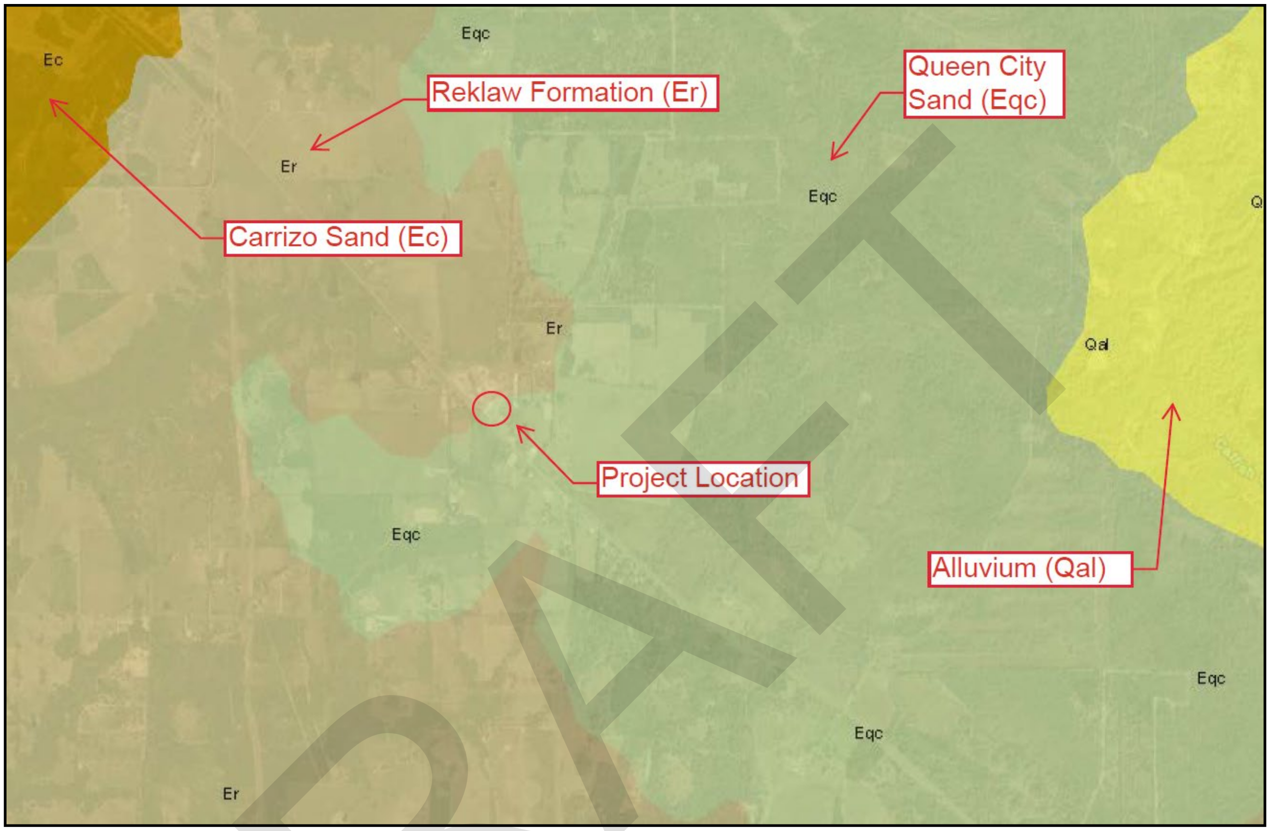
Our scope of services did not include environmental services or testing. We can provide these services or testing at your request.

B. Results

B.1. Geologic Overview

Based upon our review of available geologic resources, the site is located on the border of the Reklaw Formation and Queen City Sand Formation. The Reklaw Formation generally consists of clays, silts, and sandstone. The Queen City Sand Formation generally consist of fine to medium grain quartz sands and clays. The surface materials at this site are generally comprised of silty sand, sandy lean clay, underlain by deeper deposits of clayey sand, silty sand, fat clay, and poorly graded sand with silt to the termination depth of the borings. Below is a geologic map for the area with the site location shown in red.

Figure 3. Geologic Map (https://txpub.usgs.gov/txgeology/).



We based the geologic origins used in this report on the soil types, laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

B.2. Boring Results

The following Table provides a summary of the soil boring results, in the general order we observed the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in this Table.

Table 3. Subsurface Profile Summary*

Strata		Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
I	Existing Pavement	--	--	▪ Only observed in Boring ST-02 from the ground surface to approximately 6 inches below existing grade (BEG). ▪ Consisted of approximately 3 1/4 inches of asphalt and approximately 3 inches of apparent aggregate base.
II	Possible Fill	SM	--	▪ Only observed in Boring ST-01 from the ground surface to approximately 6 feet BEG. ▪ Contained clay lenses. ▪ Grayish brown in color.
III	Topsoil	SM, CL	--	▪ Observed in all borings except borings ST-01 and ST-02, ranging from ground surface to approximately 4 to 5 inches BEG. ▪ Consisted of silty sand and sandy lean clay. ▪ Contained trace roots towards the surface. ▪ Brown to light brown in color.
IV	Silty Sand	SM	Weight of hammer (WOH) to 50 blows per foot (BPF)	▪ Observed in all borings except Boring ST-01. ▪ Light brown, brown, and reddish brown in color. ▪ Very loose to very dense in relative density.
V	Clayey Sand/ Silty Clayey Sand	SC, SC-SM	2 to 50 blows for 4 inches of penetration	▪ Observed in all borings except borings ST-04 and ST-10. ▪ Light brown, gray, reddish gray, brown, and reddish brown in color. ▪ Very loose to very dense in relative density.
VI	Lean Clay / Sandy Lean Clay	CL	8 to 28 BPF 2.0 to 3.75 Tons per square foot (TSF)	▪ Observed in borings ST-03, ST-04, ST-05, ST-06, ST-07, and ST-10. ▪ Light brown, reddish brown, reddish gray, and light gray in color. ▪ Medium to very stiff in relative consistency.
VII	Fat Clay	CH	12 BPF	▪ Only observed in Boring ST-10, approximately from 13 to 18 feet BEG. ▪ Light gray in color. ▪ Stiff in relative consistency.

Strata		Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
VIII	Poorly Graded Sand with Silt	SP-SM	5 BPF to 50 blows for 4 inches of penetration	▪ Observed in borings ST-01, ST-02, ST-08, ST-09, and ST-10. ▪ Light brown and light gray in color. ▪ Loose to very dense in relative density.

*Abbreviations defined in the attached Descriptive Terminology sheets.

B.3. Free Water

The following Table summarizes the depths where we observed free water; the attached Log of Boring sheets in the Appendix also include this information and additional details.

Table 4. Free Water Summary

Location	Approximate Surface Elevation*	Approximate Depth to Free Water During Drilling (ft)	Approximate Free Water Depth Immediately After Auger Withdrawal (ft)	Corresponding Highest Approximate Free Water Elevation Recorded (ft)
ST-01	345	3	3	342
ST-02	352.7	5	8	347.7
ST-03	362	Not Observed	Not Observed	--
ST-04	368.1	19	19	349.1
ST-05	360.5	5	6	355.5
ST-06	369.1	4	6	365.1
ST-07	366.1	13	14	353.1
ST-08	363	10	10	353
ST-09	363.4	5	7	358.4
ST-10	368.9	3	6	365.9

*Ground surface elevations were gathered from a Submeter Global Positioning System (GPS) device.

It is difficult to accurately predict the magnitude of subsurface water fluctuations that may occur following periods of inclement weather. Water can be encountered above any of the less permeable soils and can flow through fissures, sandier soils, and fills, creating a temporary perched water condition, particularly during wetter seasons. Water levels should be expected to fluctuate throughout the year with variations in precipitation runoff, irrigation, site topography, utilities, and water levels from nearby surface water features and other factors not evident at the time of this study.

Free water may take days or longer to reach equilibrium in a borehole and we immediately backfilled the borings in accordance with our scope of work. If the project team identifies a need for long-term free water readings, piezometers should be installed and monitored. Project planning should anticipate seasonal and annual fluctuations of free water. These free water observations may not reflect actual free water levels at these sites.

B.4. Laboratory Test Results

The boring logs included in the Appendix show the results of the Atterberg limits, moisture content, and percent finer than the No. 200 sieve tests we performed, next to the tested sample depth. The Table below shows the range of the test results.

Table 5. Laboratory Tests – Range of Results

Soil Type	Moisture Content Range (%)	Percent Passing a #200 Sieve	Liquid Limit Range (%)	Plastic Limit Range (%)	Plasticity Index Range
Silty Sand (SM)	4 to 21	18 to 37	--	--	--
Clayey Sand/ Silty Clayey Sand (SC, SC-SM)	8 to 21	18 to 49	18 to 40	9 to 16	6 to 27
Lean Clay / Sandy Lean Clay (CL)	8 to 19	51 to 68	28 to 41	11 to 14	17 to 28
Fat Clay (CH)	26	--	76	20	56
Poorly Graded Sand with Silt (SP-SM)	15 to 24	5 to 8	--	--	--

Unconfined compressive strength tests were performed on selected cohesive soils. The test results are provided below.

Table 6. Unconfined Compressive Strength Test Results

Boring ID	Depth (ft)	Moisture (%)	Dry Density (pcf)	Unconfined Compressive Strength (tsf)
ST-03	13-15	17.5	112.9	2.33
ST-04	6-8	17.3	111.6	2.31

One-dimensional free swell tests were also conducted to further review the shrink/swell potential. The measured swell values are provided below:

Table 7. Free Swell Test Results

Boring ID	Depth (ft)	Liquid Limit (LL)	Plastic Limit (PL)	Plastic Index (PI)	In-Situ Moisture (%)	Final Moisture (%)	Load (psf)	Percent Vertical Swell
ST-07	6-8	28	14	14	19.4	36.7	805	0.7
ST-09	6-8	27	13	14	14.4	30.0	805	0

In addition, water-soluble sulfate tests were conducted in general accordance with TEX-145-E. The results are presented in Table 8 below.

Table 8. Soluble Sulfate Test Results

Boring ID	Depth (ft)	Sulfate Level (ppm)
ST-04	0 - 1.5	0
ST-05	2.5 - 4	100
ST-09	0 - 1.5	0

The soluble sulfate test results for the near-surface samples collected show a low concentration (<3,000 ppm) of sulfates. Based upon the TxDOT Guidelines for Treatment of Sulfate-Rich Soils and Bases, the near surface soils may be treated with calcium-based stabilization agents including lime or cement.

C. Recommendations

C.1. Design and Construction Discussion

C.1.a. Introduction

Based on the results of our subsurface exploration, the soils appear suitable for support of the proposed structures using shallow foundations consisting of either spread footings or concrete slab-on-grade foundations after performing the subgrade improvements outlined in Section C.2. below.

As requested, we have also provided straight drilled shaft foundation recommendation to support the proposed light poles and sport lights. This drilled shaft recommendations are presented in section C.4.

C.1.b. Existing Fill

Apparent existing fill materials were observed in Boring ST-01 that extended to a depth of approximately 6 feet below existing grade (BEG). Fill materials which were uncontrolled (placed without observation or compaction testing), and thus which neither the purpose or method of compaction was verified and documented, should generally not be relied upon for structural support due to the risk of differential strength and compressibility of the fills. The primary risk associated with existing uncontrolled fill materials include excessive settlement of the fill under the proposed loads, the presence of unsuitable materials such as topsoil or debris below or within the fill, and risk of heave for unknown expansive soils within the uncontrolled fill body. We recommend performing test pits at the time of construction to verify the soil conditions at the time of construction and the extend of the existing fill.

C.1.c. Native Soil Conditions

The current site stratigraphy generally consists of silty sand, sandy lean clay, underlain by deeper deposits of clayey sand, silty sand, fat clay, and poorly graded sand with silt to the termination depth of the borings.

The PVR values from the soil borings performed in the planned foundation areas were calculated in their current and dry states and are shown in the following Table.

Table 9. Calculated PVR Values

Structure	Corresponding Borings	Approximate PVR Current State (inches)	Approximate PVR Dry State (inches)
Ag Science Building Addition	ST-01 and ST-02	Less than 1	Less than 1
New Baseball Field	ST-05, ST-06, and ST-07	Less than 1	Less than 1
New Softball Field	ST-07, ST-08, and ST-09	Less than 1	Less than 1
Discus/ Shotput Facility	ST-07 and ST-10	Less than 1	Less than 1

Additionally, based on the assumed loads we performed a settlement analysis for each of the structures. At a few of the borings locations we observed soft/loose soils near the surface that are subject to consolidation/ settlement under the proposed loads. Therefore, shallow removals and densification of the loose sands will be required to provide a suitable subgrade for support of the proposed structures and to limit settlement to less than 1 inch.

Table 10. Calculated Settlement

Structure	Assumed Structural Loads (kips)	Corresponding Borings	Approximate Settlement (inches)
Ag Science Building Addition	60	ST-01	1-1/4
Baseball Field Press Box	45	ST-05	1-1/4
Softball Field Press box	45	ST-08	1-1/2

C.1.d. Reuse of On-Site Soils

Based on the results of the laboratory analysis, portions of the on-site silty sand and clayey sand soils encountered near the surface comply with select fill criteria and may be considered for reuse in select fill applications, if adequately compacted. Note, the silty sands are easily disturbed and are prone to "pumping" (become unstable when manipulated) when wet. Additional discussion regarding construction disturbance is provided in the following section.

Soils intended for select fill should be verified through laboratory analysis and approved prior to reuse. Imported materials should also meet the requirements of select fill outlined in section C.2.f. below.

C.1.e. Construction Disturbance

It is recommended that the construction documents stipulate that the methods, means, and sequence of the proposed construction shall be the responsibility of the project contractor; this is also consistent with customary practice. However, the following includes several considerations relevant to sitework.

The contractor should be aware that the on-site soils are susceptible to disturbance and loss of stability if subjected to repeated construction traffic, especially during wet ground conditions. Disturbance of these soils may cause areas that were previously prepared, or that were suitable for pavement or structure support, to become unstable and require additional moisture conditioning and compaction. Mechanical aeration, treatment with chemical additives, or excavating and replacing the disturbed material with select or other fill such as crushed, coarse gravel, free of fines are also alternatives. The contractor should use appropriate means and methods to limit disturbance of the soils, especially when wet.

Also, ponding of water should be avoided by appropriate measures including temporary grading, interceptor swales or diversions, and shallow drainage ditches. Smooth drum rolling of loosened or disturbed areas to better “shed” water and limit infiltration should be considered in advance of rain. During wet ground episodes, manipulation of subgrade may result in loss of stability and render soils excessively wet. “Protection of completed work” provisions may also include protecting existing subgrade from damage by contractor’s operations, especially when wet.

A contractor may claim that soils are or have become “excessively wet” and therefore are “unsuitable” and must be replaced at additional cost. We suggest that how such a claim is to be evaluated should be stipulated in the contract. Evaluation may depend on whether the contractor has allowed (or caused) the soils to become unstable due to manipulation when wet, whether ponding was allowed to degrade the soils, and whether the exposed soils were not adequately protected from rainfall and runoff as outlined above.

C.1.f. Surface Drainage

To account for potential rainfall during construction, we recommend maintaining construction grades and providing other necessary diversion or conveyance measures to intercept and exclude surface water runoff into the area and facilitate drainage of water from the area to an appropriate outlet or collection point. For example, excavated areas could be sloped toward one corner to facilitate removal of any collected rainwater, groundwater, or surface runoff. Positive surface drainage away from work areas should be provided at all times. After grading, the contractor should compact the soil surface with a smooth drum roller to reduce the potential for water to infiltrate into the soil. After rain events, the contractor should limit construction traffic until the surface is dry enough that traffic will not mix accumulated surface water into the soil.

As the planned construction will be adjacent to an existing building, roof drainage from existing nearby structures should not be allowed to enter or pond in active construction areas. Special measures to intercept and convey such roof runoff may be needed.

C.1.g. Pavement Considerations

The general pavement design information presented in this report is based on subsurface conditions inferred by the borings performed at this site, the Portland Cement Association, the American Association of State Highway and Transportation Officials (AASHTO), the Texas Department of Transportation (TxDOT), the Federal Highway Administration (FHWA), and experience in the locale. The published information was utilized in conjunction with the available field and laboratory test data to develop a general pavement design based on the AASHTO structural numbering system.

C.2. Site Grading and Subgrade Preparation

Spread footing foundations or slab-on-grade foundations in conjunction with the recommended subgrade modification listed in the following section may be utilized for the proposed structures.

C.2.a. Building, Baseball, Softball, and Discuss/Shotput Fields Subgrade Preparation

Prior to the placement of select fill or footings, we recommend the following steps be performed below the structure footprints, including their oversized areas as described in Section C.2.b:

1. Strip all unsuitable soils consisting of existing pavements, topsoil, organic soils, trees (including their associated root masses), vegetation, and existing utilities from the footprint of the proposed structures, pavement and playing fields.

2. After removal of unsuitable soils, additional removals to remove soft/loose soils below each of the proposed structure/playing fields should be performed according to the following Table.

Table 11. Approximate Removal Depths

Structure	Corresponding Boring Locations	Approximate Removal Depth (feet)**
Ag Science Building*	ST-01 to ST-02	Scarify the bottom of excavation to 12 inches, condition and recompact. However, we recommend performing test pits at the time of construction to confirm presence of existing fill material. If existing fill material are encountered, they should be completely removed below the structure footprint and its oversized areas.
Grandstand and Press Box (Baseball Field)	ST-05	2 feet below existing grade or to approximate elevation 358 feet. Scarify the bottom of excavation to 6 inches, condition and heavily surface compact.
Grandstand and Press Box (Softball Field)	ST-08	3 feet below existing grade or to approximate elevation 360 feet. Scarify the bottom of excavation to 6 inches, condition and heavily surface compact.
Baseball Field	ST-05 to ST-07	Once all unsuitable soils mentioned above are removed and the site has been cut to grade, no additional removals are required provided the subgrade is stable and passes a proof roll. Some scarification and re-compaction may be necessary depending on ground condition at the time of construction.
Softball Field	ST-07 to ST-09	
Discus/Shotput Field	ST-07 and ST-10	

* Please note that due to overhead powerlines and utilities Boring ST-01 was shifted away from the footprint of the proposed building addition, thus actual soil profile may differ.

**Note, if free water is present at the time of construction, it should promptly be removed. Dewatering of shallow free water should be performed prior to performing surface compaction.

3. Proof roll the subgrade as described in Section C.2.e. Weak or yielding areas should be removed.

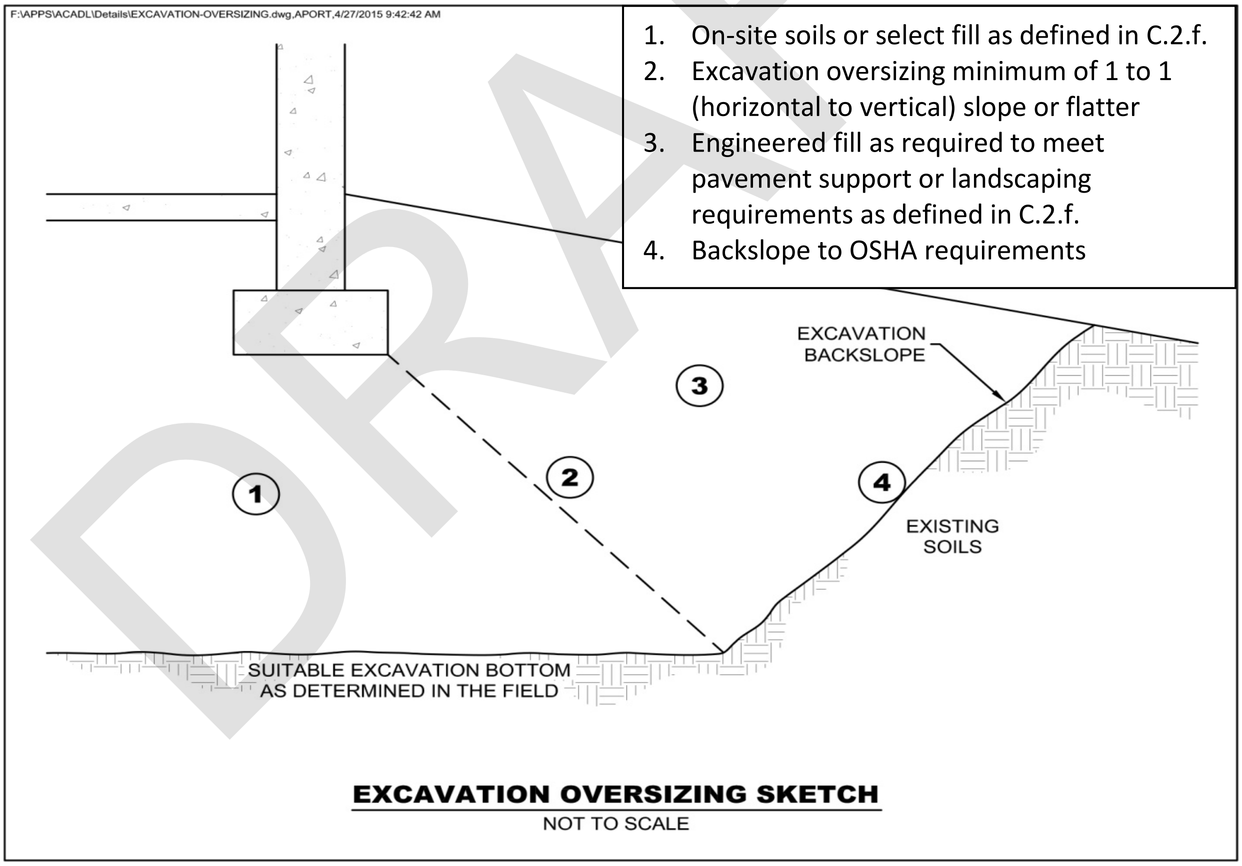
4. Backfill with qualified on-site soils or imported soils meeting the requirements of select fill as recommended in Section C.2.f. Soils should meet the requirements of Table 12 and be installed per Table 13.

The contractor should use equipment and techniques to minimize soil disturbance. If soils become disturbed or are wet, the contractor may need to use mechanical aeration to facilitate drying, or excavation and replacement with select fill, or other means such as chemical additives to dry and improve soil shear strength. Braun can provide appropriate recommendations based on additional evaluation during construction.

C.2.b. Excavation Oversizing

When removing unsuitable materials below structures or pavements, we recommend the excavation extend outward and downward at a slope of 1H:1V (horizontal: vertical) or flatter. See the Figure below for an illustration of excavation oversizing. At a minimum, the excavation should extend 5 feet outside of the structures or other perimeter features sensitive to differential movement. Some post-construction drying and settlement of the fill should be expected.

Figure 4. Generalized Illustration of Oversizing



C.2.c. Excavated Slopes

Based on the borings, we anticipate on-site soils in excavations will consist of silty sand, clayey sands, and sandy lean clay. Cohesive soils may be considered Type B soils, and soils consisting predominately of silt and sand should be considered Type C soils under OSHA (Occupational Safety and Health Administration) guidelines. OSHA guidelines indicate unsupported excavations in Type B soils should have a gradient no steeper than 1H: 1V, and in Type C soils should be no steeper than 1.5H:1V. Slopes constructed in this manner may still exhibit surface sloughing. OSHA requires an engineer to evaluate slopes or excavations over 20 feet in depth.

An OSHA-approved qualified person should review the soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, “Excavations and Trenches.” This document states excavation safety is the responsibility of the contractor. The project specifications should reference these OSHA requirements.

C.2.d. Excavation Dewatering

At the time of drilling free water was observed as shallow as 3 feet below existing grade at this site. Depending on free water elevation at the time of construction dewatering may be necessary.

Sumps and pumps can be considered for excavations in low-permeability silt and clay-rich soils, or where groundwater can be drawn down 2 feet below the bottoms of excavations in more permeable sands. In large excavations, or where groundwater must be drawn down more than 2 feet, a well contractor should review our logs to determine if wells are required, how many will be required, and to what depths they will need to be installed.

An alternative dewatering method would be to dig bleeder ditches around the perimeter of the proposed structures (a minimum of 5 feet outside of the building footprints) that extend a minimum of 2 feet below the anticipated excavation bottoms. These ditches should be drained to a low spot outside of the building footprint, where groundwater can be pumped off-site or gravity drain to an appropriate discharge point.

In sands, we do not recommend attempting to dewater from within an excavation. Upward seepage will loosen and disturb the excavation bottom. Rather, groundwater should be drawn down at least 2 feet below the anticipated excavation bottom in advance of excavation.

C.2.e. Subgrade Proof Roll

After preparing the subgrade as described above and prior to the placement of select fill, the subgrade soils should be proof rolled in accordance with TxDOT Item 216. We also recommend having our geotechnical representative observe the proof roll. Areas that fail the proof roll likely indicate wet, soft, or weak areas that will require additional soil correction work to support structures or pavements.

The contractor should correct areas that display yielding or rutting. Possible options for subgrade correction include moisture conditioning and re-compaction, excavation (undercutting) and replacement with re-compacted soil or crushed aggregate, chemical stabilization and/or geosynthetics (drainage layers or geogrids). We recommend performing a second proof roll after the select fill material or aggregate base material is in place, and prior to constructing of pavements.

C.2.f. Engineered Fill Materials and Compaction

The following Table contains our recommendations for fill materials.

Table 12. Fill Materials

Locations To Be Used	Fill Classification	Possible Soil Type	Gradation	Additional Requirements
Mass grading (outside building footprints and oversized areas)	General Fill	CL, SM, SW, SC, SP	1. 100% passing 3-inch sieve 2. 60% maximum passing No. 200 sieve	1. Liquid Limit <50 2. Plasticity Index < 35 3. <2% OC
Below Foundations, floor slabs, and Athletic Fields	Select Fill	SC, CL	1. 100% passing 3-inch sieve 2. 60% maximum passing No. 200 sieve	1. Liquid Limit <35 2. Plasticity Index between 8 and 18 3. < 2% Organic Content (OC)
	On-site Soil	SC, SM	1. 100% passing 3-inch sieve 2. 40% maximum passing No. 200 sieve	1. Liquid Limit <35 2. Plasticity Index between 0 and 15 3. < 2% Organic Content (OC)
Pavement Subgrade	Crushed Aggregate Base	–	Grades 1 or 2 as specified by TxDOT Item 247	Type A, B, or D as specified by TxDOT Item 247
	Select Fill or Onsite Soils	SC, CL	100% passing 3-inch sieve	1. Liquid Limit <45 2. Plasticity Index between 8 and 20 3. < 5% Organic Content (OC)
	Cement-Treated On-Site Soils	--	See TxDOT Item 275	See Section C.6.c
Below landscaped surfaces, where subsidence is not a concern	Non-Select Fill	–	100% passing 6-inch sieve	< 10% OC

We recommend spreading fill in loose lifts of approximately 8 inches thick. We recommend compacting fill in accordance with the criteria presented in the following Table. The project documents should specify compaction criteria (density and moisture range) for the fill, based on the structure located above the fill, and vertical proximity to that structure.

Table 13. Compaction Recommendations Summary

Reference	Recommended Compaction, percent (ASTM D698 – Standard Proctor)	Moisture Content Variance from Optimum, percentage points
Select fill below foundations, floor slabs, playing fields, and paving	95 (minimum) for fill depths less than 5 feet	-2 to +2
	98 (minimum) for fill depths 5 feet and greater	
Crushed Aggregate Base	98 (minimum)	-2 to +2
Below landscaped surfaces	92	±4

We recommend performing density tests in the fill to evaluate if the contractors are effectively compacting the soil and meet project requirements. Table 14 contains our recommended frequency of testing for various aspects of the project.

Table 14. Fill Testing Frequency

Zone Designation	Fill Testing Frequency	Minimum Tests per Soil Lift
Building Pad	1 test per every 2,500 square feet	2
Playing Fields	1 test per every 5,000 square feet	2
General Parking Areas	1 test per every 5,000 square feet	2
Utility Lines	1 test every 150 linear feet	1 Test per every 1 foot of fill
Grade Beams	1 test every 150 linear feet	1 Test per every 6” compacted lift

C.2.g. Inspections of Soils

The purpose of soil inspections is to evaluate whether the work is in accordance with the approved Geotechnical Report for the project. Inspections should include evaluation of the subgrade, observing preparation of the subgrade (surface compaction or dewatering, excavation oversizing, placement procedures and materials used for fill, etc.) and compaction testing of the fill.

C.2.h. Spread Footing Foundations

The following Table contains our recommended design parameters for spread footing foundations bearing on select fill in accordance with Section C.2.f.

Table 15. Recommended Spread Footing Design Parameters

Item	Description
Maximum net allowable bearing pressure (psf) bearing on select fill or on-site soil	2,500
Factor of Safety for above allowable bearing pressures	3
Minimum width (inches) Isolated spread footings Perimeter Strip footings	 24 18
Minimum embedment below final exterior grade for structures (inches)	18
Total estimated settlement (inches)	1 inch
Differential settlement	Typically, about 2/3 of total settlement*

* For compacted select fill and native soils, the recommended allowable passive resistance is 190 psf/ft (triangular earth pressure distribution). An allowable coefficient of friction equal to 0.33 is recommended for evaluating sliding resistance.

C.3. Concrete Slab-on-Grade Foundation

C.3.a. General

As an alternative to supporting the structure on individual and continuous or “strip” footings, the structures can also be supported on a conventionally reinforced concrete slab-on-grade foundation (with the exception of the gymnasium) bearing on engineered fill. This type of foundation typically employs perimeter footings cast monolithically with the floor slab. Individual footings may also be used for “spot” loads if significant; in some designs, these may be constructed as an area of “thickened slab.” Some designs also use interior “cross beams” or grade beams. The same subgrade improvements as presented in Section C.2 should be provided.

Continuous footings or grade beams below load bearing walls and at regular intervals may still be required by the structural design. Perimeter grade beams should bear at a minimum nominal depth of 18 inches below the planned adjacent grade. Interior individual footings, grade beams and cross beams should extend a minimum of 12 inches below the bottom of the slab, or deeper as may be required by the structural design or details. It is acceptable to bear the slabs and grade beams within properly placed engineered fill or firm, native soils. All fill soil should be tested and approved in accordance with the recommendations presented in this report. Minimum widths for grade beams should be 12 inches even if the bearing pressures are less than the recommended values.

C.3.b. Allowable Bearing Capacity

The grade beams for continuous loads, may be designed for maximum net allowable soil bearing capacities of 2,500 psf provided the beams bear on compacted select fill as outlined in Section C.2.

Foundations designed and construction utilizing the recommendations for a modified subgrade presented herein are anticipated to have a total vertical movement of less than 1 inch.

C.3.c. Excavation Observations

All excavations should be observed by a Braun Intertec representative prior to steel and concrete placement to assess whether the bearing soils are consistent with the boring logs. Further, all footing and grade beam locations should be probed, density-tested, and approved by a Braun Intertec representative prior to placing steel reinforcing. Soft or loose soil zones observed at the bottom of the excavations should be removed and the cavity should be backfilled with compacted select fill, “flowable” grout fill, crushed stone flexible base, concrete, or other approved material with the appropriate placement controls.

C.4. Straight Drilled Shafts (Light Poles and Sport Lights)

Straight drilled shafts may be utilized to support the lights poles within the proposed asphalt parking lot and the associated sport lights within the new baseball, softball and shot put/discus fields.

The drilled shafts (also known as drilled piers or caissons) should be designed to have a minimum penetration depth in accordance with Table 16. The final depth of penetration should be determined by a representative of the geotechnical engineer in the field. Table 16 below contains our recommended design parameters for straight drilled shafts.

Table 16. Recommended Drilled Shaft Design Parameters

Item	Description	
	Straight Sided Drilled Shafts	
	Light Poles within Asphalt Parking Lot	Sport Lights
Corresponding Borings	ST-3 and ST-4	ST-5 to ST-10
Bearing Stratum	Sandy Lean Clay/ Lean Clay	Silty Sand/ Clayey Sand/ Sandy Lean Clay
Minimum Embedment Depth*	10 feet	12 feet
Maximum Allowable Bearing Pressure	3,500 psf	4,500 psf
Allowable Skin Friction - Compression	450 psf	250 psf
Allowable Skin Friction - Tension	250 psf	100 psf
Factor of safety end bearing	3.0	
Factor of safety skin friction	2.0	
Minimum shaft diameter	18 inches	
Total estimated settlement**	Less than 1 inch	

* Field Adjustments may be required depending on free water level encountered during installation.

**Actual total settlement amounts will depend on final loads. We can evaluate total settlement based on final foundation plans and loadings.

Settlement of a properly constructed drilled shaft as recommended are expected to occur as the drilled shaft is loaded. Total settlements are estimated to be less than 1-inch. Minimum shaft diameter for inspection and constructability purposes is 18 inches.

C.4.a. Group Effects for Axial Loads

In order to develop allowable bearing resistance given in Table 16, we recommend that adjacent shafts maintain a minimum center to center spacing of 2.5 times the diameter of the larger shaft. Closer spacing will require reductions in the skin friction values presented above, and possibly special installation sequences. As a general guide, the design skin friction will vary linearly from the full value at a spacing of 2.5 diameters to 50 percent of the design value at 1.0 diameter.

Groups of three or more shafts spaced closer than 2.5 shaft diameters, or groups of shafts with uplift loads, should be evaluated on a case-by-case basis by this office. Alternative installation sequences should be implemented during group shaft installation to allow for a minimum of 48 hours curing time for concreted shafts, before installation of adjacent shafts.

C.4.b. Drilled Shaft Support

Please refer to Table 4 summarizing the depths where we observed free water in our borings, which should be anticipated during construction of the drilled shafts. In addition, the borings encountered sandy soils that prone to caving. Based on our borings, we anticipate the drilled shafts will likely require casing to prevent the infiltration of groundwater and maintain the integrity of the shaft excavation. Project planning and budgeting should anticipate the need for casing.

C.4.c. Lateral Loading Considerations

Our recommended lateral load design parameters for use in the L-Pile computer program are provided below in Table 17.

Table 17. Recommended L-Pile Parameters for Soil

Stratum	Soil Type	Depth Range (ft)	p-y Model	Effective Unit Weight (pcf)	Undrained Shear Strength (psf)	Strain Factor ε_{50}	Friction Angle (degrees)	k_s value (pci)
1	Silty Sand/ Clayey Sand (SM, SC)	0 to 5	Neglect upper 5 feet, except for unit weight	120	--	--	--	--
2	Sandy Lean Clay (CL)	2 to 20	Neglect upper 5 feet, except for unit weight	115	1,500	0.01	--	250
3	Silty Sand/ Clayey Sand (SM, SC)	5 to 20	Medium Dense Sand w/ free water	65	--	--	32	60
4	Poorly Graded Sand with Silt (SP-SM)	20 to 25	Dense Sand w/ free water	65	--	--	35	125

The program models the pile behavior using a finite difference method and determines the non-linear response of the soil using various soil resistance-pile deflection (p-y) criteria. The program accommodates the analysis of various pile types subjected to axial load, lateral load, and bending moments. Braun Intertec recommends that the design neglect the upper 5 feet of soil, except for the unit weights, and also size the drilled piers and select appropriate reinforcing steel to resist the anticipated forces.

C.4.d. Concrete Placement

Prior to placing concrete in drilled shaft excavations, we recommend the use of a cleanout bucket to remove any soft sediments or disturbed soil from the bottom of the excavation. Proper equipment and procedures for providing a clean base should be utilized during construction; otherwise, end bearing should be neglected.

Concrete should be placed with a bottom discharge bucket, flexible drop chute, elephant trunk hopper, or tremie. Free-fall of concrete may be used if the excavation is dry or contains less than two inches of water at the time of placement. The concrete mix should be designed to prevent segregation and the concrete should be directed through a hopper or chute such that the fall is down the center of the shaft without contacting the sides of the shaft or reinforcing steel. The volume of concrete placed should be checked against the calculated volume required to obtain design shaft dimensions and the percent theoretical volume reported to the geotechnical engineer and structural engineer in a timely manner. A geotechnical engineer should observe drilled shaft construction.

If prior to placing concrete, more than two inches of uncontaminated free water is present in the shaft, we recommend removing the excess water. Alternatively, the concrete can be placed with a tremie pipe, although the concrete should then be designed for a slump between approximately 8 to 10 inches.

C.4.e. Drilled Shaft Construction Considerations

We recommend installing the shafts in general accordance with American Concrete Institute (ACI) 336.1-96, "Standard Specification for the Construction of Drilled Piers" and the 2010 FHWA Drilled Shaft Manual. Where these references are in conflict, recommendations in the newer references should prevail.

C.4.f. Special Inspections of Drilled Shafts

The drilled shafts should be constructed under the guidelines of Special Inspections as provided in Chapter 17, of the IBC, which requires full time observations throughout foundation installation including drilling observations, cleaning and suitability of bearing stratums, concrete placement. This work should be carried out under the direction of a licensed geotechnical engineer. The purpose of these special inspections is to evaluate whether the work is being carried out in accordance with the approved

Geotechnical Report for the project and the requirements of the approved plans, specifications, and compaction testing of the fill.

C.5. Floor Slab Considerations

The slab subgrade should be uniform, smooth, and level, so that the slab thickness is uniform. Otherwise, cracking will likely occur at discontinuities.

C.5.a. Modulus of Subgrade Reaction

A slab-on-grade floor system can be constructed provided the building pad area is prepared as recommended in Section C.2 of this report. To design slab-on-grade systems, structural design methods typically incorporate a subgrade modulus value, or spring constant. In general, the subgrade reaction modulus is typically denoted as “k” or “K” and has units of pounds per square inch per inch of deflection (psi/in, or pci). The appropriate k-value for a particular loading situation depends on several soil and structural parameters, such as, but not limited to, soil type, soil uniformity, soil consistency, soil strength, structural load, duration of structural loads, and breadth of the area over which structural loads are acting.

The “point load” modulus, or also referred to as the short-term modulus, typically denoted as K_p, is applied to short-duration load situations, or transient loads, such as wheel loads from transport vehicles and forklifts. In this scenario, the modulus of subgrade reaction is based on published data obtained from 30-inch diameter plate load tests for a given soil condition. The result of a standardized plate load test typically describes the near-surface subgrade modulus, commonly applied to the upper 2 to 3 feet of the subgrade soils directly beneath the concrete.

For heavily loaded slabs-on-grade, such as the concrete slabs that will support racking systems, stacks of feedstock, finished goods or other heavy loads, uniform slab loads act over a much larger relative surface area (the footprint of the back-to-back or single back racks) and, moreover, the loads are essentially non-transient (although they may fluctuate over time) and are considered to be long-term loads. The stress from long-term, wide area loads induces consolidation of underlying subgrade soils to depths well beyond the relatively shallow short-term “point” loads associated with the K_p-value. Thus, a long-term, or “wide area,” modulus value, often denoted as K_w (also having units of psi/in, or pci) must be applied to this situation.

The determination of the appropriate K_w value for a specific loading arrangement requires an iterative process between the project structural engineer and the project geotechnical engineer.

In this process, geotechnical and structural criteria data are shared and discussed; as a general rule, the more detailed and accurate the design loading arrangement is, the more precise the calculation for a system-specific K_w-value can be. For this project, based upon the available data, we recommend utilizing a preliminary K_p value of 100 pci, and a K_w value of 50 pci.

Since the effective k-value for a loaded area is dependent on the size of the loaded area, the following relationship should help in estimating a size-adjusted k-value:

$$K_f = K^*((B + 0.5 \cdot B/L)/(1.5 \cdot B))$$

where B is the width and L is the length of the loaded area. K_f is the adjusted K-value (using K_P or K_W for K in the above equation, as appropriate) for a given size of loaded area. The structural engineer should perform a parametric sensitivity analysis, and if the design is sensitive to the assumed K_f value more detailed analyses are warranted.

Other items that may impact the final slab thickness and factor of safety used to design the slabs are items such as construction quality control measures and field oversight that would be implemented for any specific project.

C.5.b. Membrane Under Slab

The decision as to whether a synthetic membrane (polyethylene or HDPE sheeting, etc.) is required below the slab should be made by the architect and structural engineer based on planned floor coverings, proximity of groundwater, planned site grading and drainage patterns, tolerance for curling, local custom, weather conditions at the time of construction, and other pertinent considerations. Generally, if adhesive-type (“glued-down”) floor coverings are planned, a synthetic membrane is advised to control, or retard, slab moisture. Otherwise, the moisture levels may exceed the upper limit for the floor manufacturer to warranty the installation.

To reduce and control curling and finish problems on floor slabs, Braun Intertec emphasizes the importance of designing a concrete mix that has minimum voids for paste (cement and water). This will require a well-graded, combined aggregate gradation.

C.5.c. Utilities through Slab

Utility lines which project through the slab should be designed with either some degree of flexibility or with sleeves. Such design features will help reduce damage to utility lines if vertical movements occur.

C.6. Pavements

C.6.a. Pavement Subgrade Preparation

Prior to the placement of engineered fill or paving components, we recommend the following steps be performed below the pavement subgrade:

1. Strip all unsuitable materials (may include buried lines, trees, including their associated root masses, debris, topsoil, organic soils, and vegetation) from the area. We recommend that our geotechnical engineering representative observe the exposed surface or bottom of the excavation prior to placing backfill to determine if additional removals are required.

2. After removal of unsuitable soils and materials mentioned above, we recommend any loose or disturbed soils be compacted according to the specifications listed in Section C.2.f.

3. Proof roll the subgrade as described in Section C.2.e. Weak or yielding areas should be removed and replaced by controlled select fill, or otherwise rendered stable by scarifying the unstable surface, and conditioning it as needed to obtain stability.

4. Have a geotechnical representative observe the excavated subgrade to evaluate if additional subgrade improvements are necessary.

5. Backfill with qualified on-site soils or imported soils meeting the requirements of select fill to achieve planned subgrade elevation. Soils should meet the requirements of Table 12 and be installed per Table 13.

6. For longer-term stabilization of subgrade soils, we recommend stabilizing at least 6 inches of the subgrade using Portland Cement.

Note that silty sand soils found on site are highly susceptible to construction disturbance when wet. However, these soils may be suitable for reuse if the desired compaction requirements are achieved. If this cannot be achieved, select fill should be imported to raise grade to final subgrade elevation or the subgrade soils should be stabilized using Portland cement or fly ash. Additional recommendations for cement stabilization are provided in Section C.6.c if cement stabilization is required to provide a suitable subgrade. We recommend maintaining a positive slope on subgrade surfaces to promote drainage and removal of accumulated water.

C.6.b. Design Sections

Based on our experience with soils anticipated at the pavement subgrade elevation, we recommend the pavement design be based on an assumed CBR value of 4 for the native soil and 10 for stabilized soil. The contractor may need to perform removal of unsuitable or less suitable soils to achieve this value. This value has been determined based on published CBR values for soils with similar index properties as the materials found at this site as well as select fill. The Table below provides recommended pavement sections, based on the soil support, and assumed traffic loads.

Table 18. Recommended Pavement Sections

Pavement Type	**Asphalt**			
Use	**Light Duty (40,000 ESALs) for automobile parking areas**		**Medium Duty (100,000 ESALs) for associated drives for buses**	
TxDOT Item 340, Type D	2 inches	1-1/2 inches	2 inches	1-1/2 inches
TxDOT Item 340, Type D or C	1-1/2 inches	1-1/2 inches	2 inches	2 inches
Crushed Aggregate Base	6 inches	6 inches	8 inches	7 inches
Cement Stabilized Subgrade	--	6 inches	--	6 inches
Total Thickness	9-1/2 inches	15 inches	12 inches	16-1/2 inches

*All materials should meet the TxDOT Standard Specifications for Highway Construction

Dumpster pads and the areas leading up to the dumpster pad should have a minimum thickness of seven (7) inches.

C.6.c. Cement Stabilized Subgrade (Optional)

For longer-term stabilization of subgrade soils or if unsuitable soils are encountered during construction, consideration should be given to stabilizing at least 6 inches of the subgrade using Portland cement. At least 6 inches (compacted thickness) of the subgrade using Portland cement (or other approved chemical additive) should be stabilized. Portland cement increases soil strength through pozzolanic reaction (cementation). Cement stabilization should be performed in accordance with the applicable provisions of TxDOT Item 275, "Cement Treatment for Materials Used as Subgrade (Road Mixed)", Texas Department of Transportation, Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 edition. The cement-stabilized subgrade should meet the gradation requirements of TxDOT Item 275.

Many variables go into evaluation of application rates of the cement. Additionally, different sources of materials will result in different resulting strengths. Therefore, we recommend a laboratory testing program be performed prior to construction to define the specific strength attributes of the selected materials. For budgeting purposes only, the preliminary application rate may be assumed to be 6% by dry weight (corresponds to an approximate application rate of 31 pounds per square yard for 6-inch treatment depth compacted). Cement series testing was not included in the scope of this project however should be performed prior to stabilization to determine the required application rate. In addition, consideration should be given to the potential for non-uniformity of soils, spillage, and other losses such as dusting and overmixing when selecting the percentage cement required for stabilization.

The cement-stabilized subgrade should be compacted to within 2 percentage points of optimum as defined by ASTM D 698 (Standard Proctor). Compaction should be at least 95 percent of the maximum dry density defined by this standard. The required moisture content and density of the compacted material should be maintained until construction is complete.

Fly ash or CKD may also be considered in lieu of Portland cement depending on availability and cost of additives. Fly ash and CKD are also cementitious additives and may provide similar results; however, these are uncontrolled by-products of power generation, and results may vary.

The contractor should correct areas that display yielding or rutting. Possible options for subgrade correction include moisture conditioning and re-compaction, excavation (undercutting) and replacement with re-compacted soil or crushed aggregate, chemical stabilization and/or geotextiles. We recommend performing a second proof roll after the select fill material or aggregate base materials are in place, and prior to constructing the paving.

C.6.d. HMA Pavement Materials

Appropriate mix designs are critical to the performance of flexible pavements. The Braun pavement group can provide recommendations for pavement material selection during final pavement design.

C.6.e. Performance and Maintenance

We based the above pavement designs on a 20-year performance life for asphalt. This is the amount of time before we anticipate the pavement will require reconstruction. This performance life assumes routine maintenance, such as seal coating and crack sealing. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

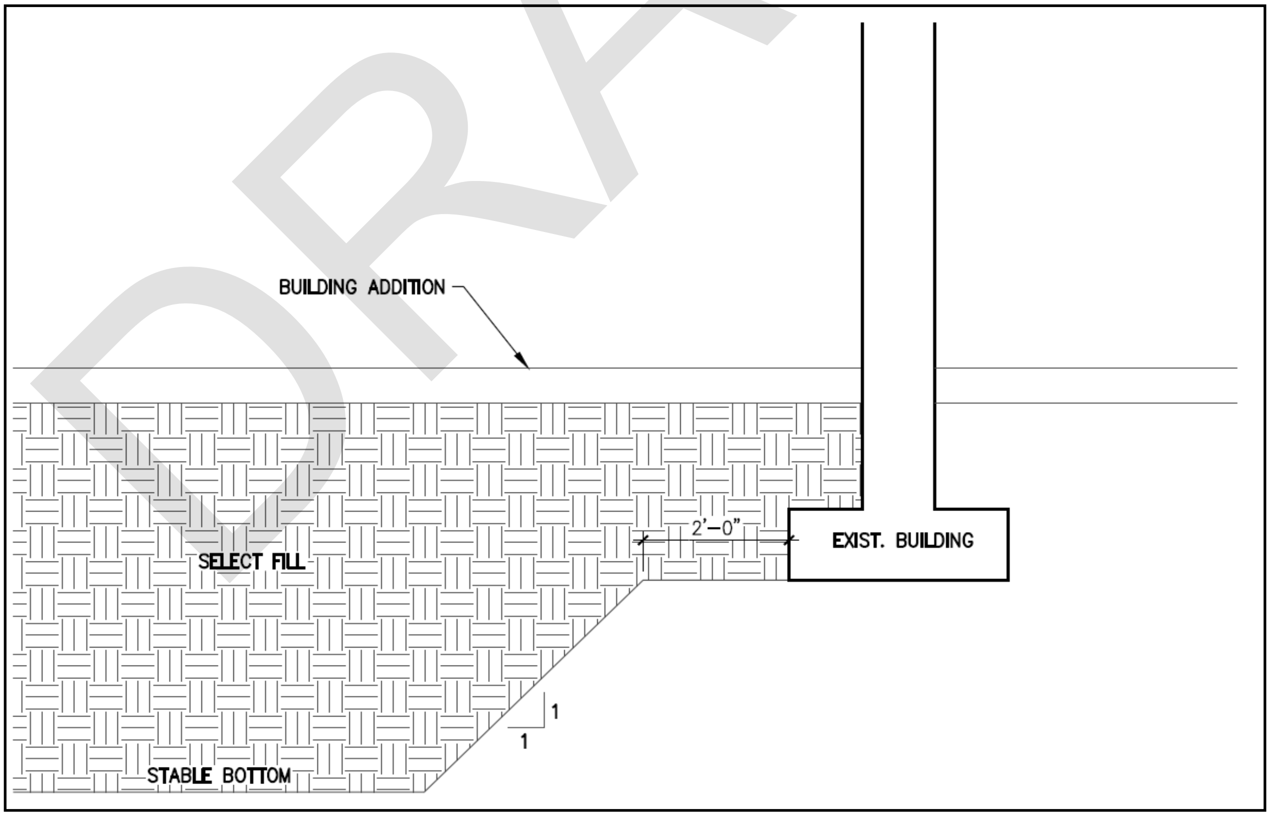
Many conditions affect the overall performance of pavements. Some of these conditions include the environment, loading conditions and the level of ongoing maintenance. We recommend developing a regular maintenance plan for filling cracks in exterior slabs and pavements to lessen the potential impacts for warm weather distress due to wetting and softening of the subgrade.

C.7. Construction Adjacent to Existing Structures

C.7.a. Excavations

Excavations to remove unsuitable soils may extend near or below existing footings. To reduce the risk of undermining the existing foundations, we recommend soil corrections and other excavation within five feet horizontally of the existing footing only extend down to the bottom of the existing footing. Beginning two (2) feet away, soil corrections should be performed at 1H:1V down and away from the existing footing. After reaching the design depth, a geotechnical representative should observe the excavation bottom to evaluate the suitability of the soils near the existing foundation for support of the new floor slabs and foundations. We recommend contacting us if excavations need to extend beyond the limits described above, as additional improvements such as ground improvement, retention or underpinning may be warranted. See Figure 5 for an illustration of excavation oversizing adjacent to existing structures.

Figure 5. Generalized Illustration of Oversizing Next to Existing Structures



During construction, the contractor should monitor the slope and structure for movement. We also recommend protecting the slope from disturbance, such as precipitation, runoff, or sloughing. The project team should establish threshold limits of movement and required action if the movement exceeds the limits.

C.7.b. Footing Depth

New building foundations constructed adjacent to the foundations of the existing building may exert additional stresses on existing foundations. In general, we recommend constructing new foundations to bear at the same elevation as the existing foundations. We also recommend lowering or offsetting foundations so a foundation or its oversize zone does not exert a load on adjacent structures.

C.7.c. Settlement

Due to possible differential rates of settlement and other movements of the existing building and the proposed addition, differential movements could occur between the existing building and the addition. To accommodate such movements, we recommend that final connections between the buildings be made later in the construction process, after most of the dead load is in place on the addition. We also recommend installing expansion joints between the existing building and the addition, or otherwise designing the structure to accommodate differential movement.

C.8. Flatwork

Flatwork elements, including sidewalk areas and paving, are subject to distress resulting from aforementioned potential vertical soils movements. It is recommended that flatwork not be rigidly connected to structures, and joints between flatwork and structures be completely filled with an elastomeric material.

Differential movements may occur between the planned slab and adjacent patios, porches, and entries if remove/replace is not provided beneath these areas. If differential movements are a concern the foundation pad can be extended beneath patio and porches. Considerations may be giving to incorporating these structures into the planned foundation system.

Adequate drainage should be provided so that runoff is not allowed to collect in areas where intrusion into subgrade soils may occur. Unless excavation of existing soils extends beyond the building pad areas, encompassing flatwork elements, some movement related soil heave or shrinkage can be expected.

C.9. Site Classification

Due to project scope limitations, we did not perform a 100-foot-deep boring recommended in the International Building Code (IBC) for seismic site classification. We conservatively assumed the overburden soil consistency extends and continues below the bottom of the borings. Based on the soil boring data and pertinent reference materials, this site meets the criteria for Site Class D, which corresponds to stiff soil profile as defined in Section 1613.3.2 of the 2012/2015 IBC and Table 20.3-1 of the 2010 ASCE-7 Standard.

C.9.a. Seismic Design Coefficients

A Risk Category of II was selected for the seismic design coefficient generation. We determined the seismic design coefficients for the site using the California Office of Statewide Health Planning and Development (OSHP) maintained information at the website: seismicmaps.org The input values included the GPS coordinates and the Site Class D soil profile. The resulting seismic design parameters for the site ae summarized in the following table.

Table 19. Seismic Design Parameters

Seismic Design Category	S_S	S_1	S_{MS}	S_{M1}	S_{DS}	S_{D1}	F_a	F_v
D – Stiff Soil	0.083	0.052	0.133	0.124	0.089	0.082	1.6	2.4

Where: F_a = site coefficient
F_v = site coefficient
S_S = Mapped spectral response acceleration for short periods
S_1 = Mapped spectral response acceleration for a 1-second period

C.10. Utilities

Earthwork activities associated with utility installations located inside the building area should adhere to the recommendations in Section C.2.

For exterior utilities, we anticipate the soils at typical invert elevations will be suitable for utility support. However, if construction encounters unfavorable conditions such as soft clay, organic soils or perched water at invert grades, the unsuitable soils may require some additional subcutting and replacement with sand or crushed rock to prepare a proper subgrade for pipe support. Project design and construction should not place utilities within the 1H:1V oversizing of foundations.

C.11. Landscaping and Trees

The effects of evapotranspiration from nearby trees can adversely affect the foundation by removing moisture from soils during dry periods through their extensive root systems, resulting in shrinkage or subsidence of the subgrade in the tree-structure proximity. Therefore, Braun Intertec recommends the following:

- Trees around the buildings should be no closer than 50 percent (50%) of the mature height of the tree.
- The structures should not be positioned within the vertical projection of mature tree canopies or drip lines.
- If trees and large bushes are placed within closer proximity of new structures, vertical root barriers to a depth of at least 4 feet below ground should be installed to inhibit the movement of the tree's roots systems under the foundation.

C.12. Equipment Support

The recommendations included in the report may not be applicable to equipment used for the construction and maintenance of this project. We recommend evaluating subgrade conditions in areas of shoring, scaffolding, cranes, pumps, lifts, and other construction equipment prior to mobilization to determine if the exposed materials are suitable for equipment support or require some form of subgrade improvement. We also recommend project planning consider the effect that loads applied by such equipment may have on structures they bear on or surcharge – including pavements, buried utilities, etc. We can assist you in this evaluation during construction.

D. Procedures

D.1. Test Boring

We drilled the test borings with an ATV-mounted drill rig. Soils were sampled using Shelby tubes and the Standard Penetration Test (SPT) split spoon barrel in accordance with ASTM D-1586 and 1587. Samples were collected at 2-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter. The boring logs show the actual sample intervals and corresponding depths.

D.2. Exploration Log

D.2.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our test borings. The logs identify and describe the penetrated geologic materials and present the results of penetration resistance and other tests performed. The logs also present the results of laboratory tests performed on test samples and groundwater measurements.

We inferred strata boundaries from changes in the test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

D.2.b. Geologic Origins

We assigned geologic origins to the materials shown on the log and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, and (3) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

D.3. Material Classification and Testing

D.3.a. Visual and Manual Classification

We visually classified the soils observed in the borings in accordance with ASTM D2488. The Appendix includes a chart explaining the classification system.

D.3.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on soils sample obtained from the borings. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM procedures.

D.4. Free Water Measurements

The drillers checked for groundwater while advancing the test borings, and again after auger withdrawal. We then backfilled as noted on the boring logs.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

We developed our evaluation, analyses, and recommendations from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation, and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

E.1.b. Free Water Level

We made free water measurements under the conditions reported herein and shown on the exploration log and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning and design should expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications, and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

E.2.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those observed by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

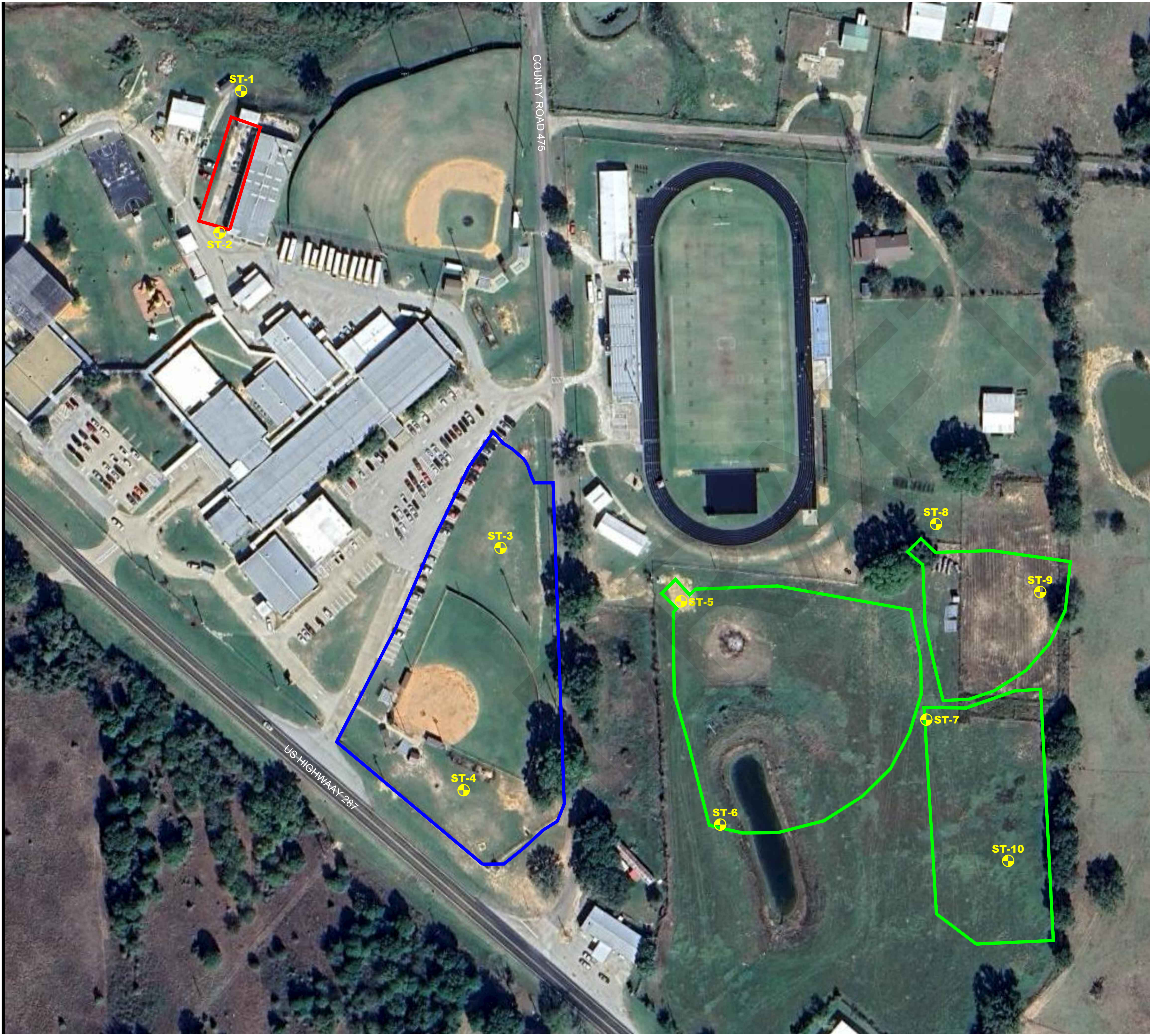
E.3. Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses, and recommendations may not be appropriate for other parties or projects.

E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix



● **SOIL BORING LOCATION**

🟥 BUILDING ADDITION

🟦 NEW ASPHALT PARKING LOT

🟩 BASEBALL, SOFTBALL, AND SHOTPUT FIELDS

N

75' 0 150'

SCALE: 1" = 150'

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2120 Brandon Drive
Tyler, TX 75703
903.581.8080
braunintertec.com

Drawing Information

Project No:	B2405535
Drawing No:	B2405335
Drawn By:	BJB
Date Drawn:	6/28/24
Checked By:	RE
Last Modified:	6/28/24

Project Information

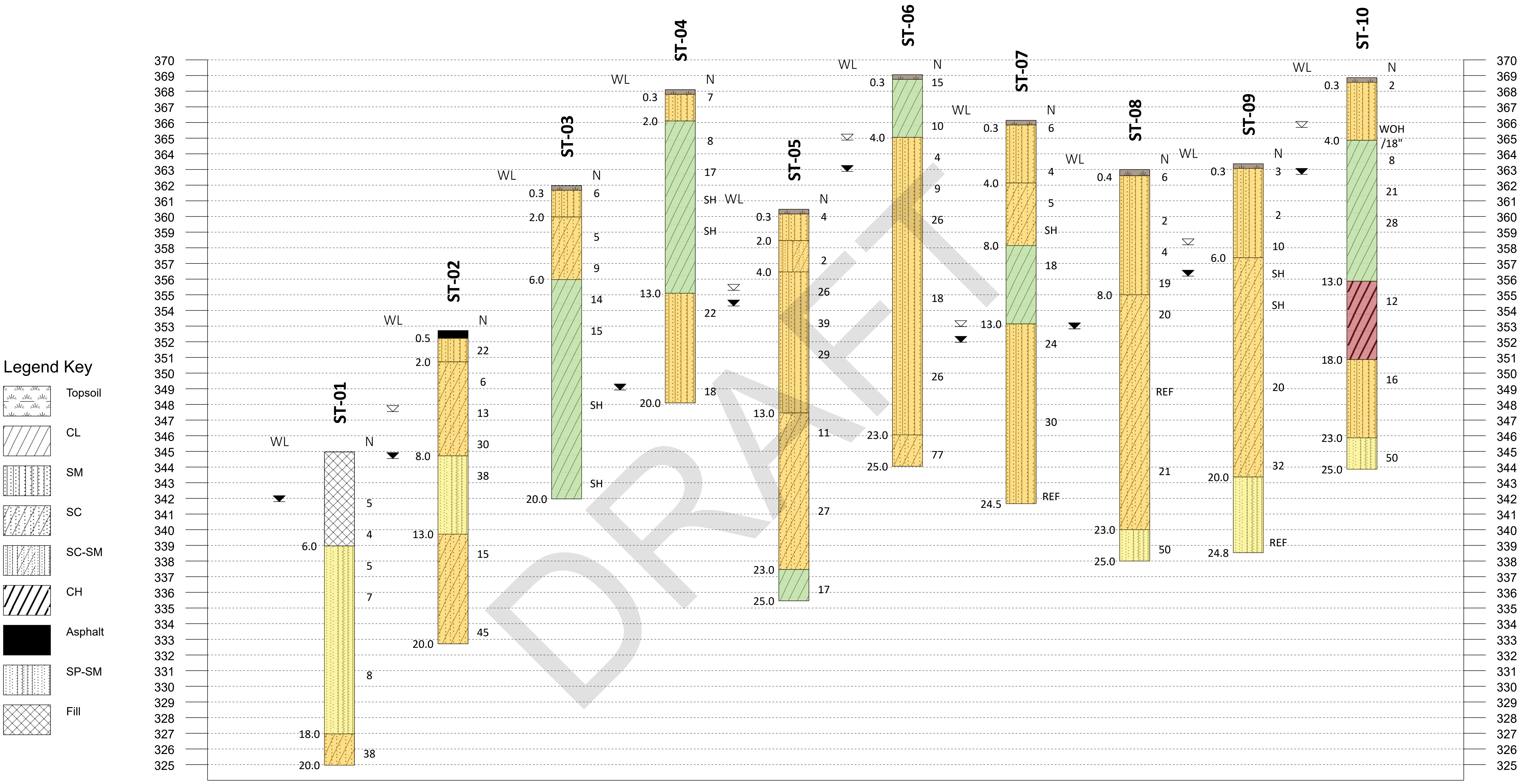
Cayuga ISD Expansion

17750 North US
Highway 287

Bethel, Texas

Soil Boring Location Sketch

F:\2024\B2405335\CAD\B2405335.dwg,Geo,6/28/2024 12:42:19 PM



Project ID: B2405335
Vert. Scale: 1"= NTS'
Hor. Scale: NTS
Date: 07/09/2024

Fence Diagram
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-01**		
LOCATION: Captured with RTK GPS.			
DATUM: WGS 84			
LATITUDE:	31.923830	LONGITUDE:	-95.923531
DRILLER:	V. Burnham/D. Velasquez	LOGGED BY:	Q. Thomas
START DATE:	06/24/24	END DATE:	06/24/24
SURFACE ELEVATION:	345.0 ft	RIG:	75010
METHOD:	Solid Stem Auger		
SURFACING:	Grass	WEATHER:	Sunny, 90's

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	q_p tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
		SILTY SAND (SM), fine-grained, with Clay lenses, grayish brown (POSSIBLE FILL)											No recovery from 0-2 feet
	▼		☒	2-2-3 (5)		16	45						
339.0 6.0			☒	3-2-2 (4)		21							
		POORLY GRADED SAND with SILT (SP-SM), medium to coarse-grained, trace Gravel, light brown, loose *Light gray from 8 to 13 feet*	☒	3-3-2 (5)		21	8						
			☒	3-4-3 (7)		22							
327.0 18.0		*Light brown from 13 to 18 feet*	☒	3-4-4 (8)		16	5						
325.0 20.0		CLAYEY SAND (SC), fine-grained, with Clay layers, light brown, dense	☒	5-8-30 (38)		21							
		END OF BORING Boring then backfilled with auger cuttings											

Depth scale: 5, 10, 15, 20, 25

Water observed at 3.0 feet while drilling.
Water observed at 3.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-02**
LOCATION: Captured with RTK GPS.	
DATUM: WGS 84	
LATITUDE: 31.923244	LONGITUDE: -95.923664
START DATE: 06/24/24	END DATE: 06/24/24
SURFACING: Asphalt	WEATHER: Sunny, 90's

DRILLER: V. Burnham/D. Velasquez	LOGGED BY: Q. Thomas		
SURFACE ELEVATION: 352.7 ft	RIG: 75010	METHOD: Solid Stem Auger	

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	q_p tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
352.2 0.5		Approximately 3 1/4 inches of Asphalt surfacing with 3 inches of Apparent Aggregate Base											
350.7 2.0		SILTY SAND (SM), fine-grained, trace Gravel, light brown, medium dense	☒	12-12-10 (22)		5	28						
344.7 8.0	▽ ▼	CLAYEY SAND (SC), fine-grained, light brown, loose to medium dense *With Clay layers from 2 to 4 feet* *Trace Gravel from 2 to 6 feet* *With Clay seams, light brown to gray from 6 to 8 feet*	☒ ☒ ☒	3-3-3 (6) 3-5-8 (13) 8-10-20 (30)		11 11 13	38 23	24 28	9 14	15 14			
339.7 13.0		POORLY GRADED SAND with SILT (SP-SM), fine-grained, trace Gravel, light brown, dense	☒	7-20-18 (38)		15							
332.7 20.0		CLAYEY SAND (SC), fine-grained, light brown, medium dense to dense *With Clay lenses from 13 to 18 feet* *Trace Gravel from 18 to 20 feet*	☒ ☒	8-8-7 (15) 8-16-29 (45)		17 15		40	13	27			
		END OF BORING Boring then backfilled with auger cuttings											

Water observed at 5.0 feet while drilling.
Water observed at 8.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-03**		
LOCATION: Captured with RTK GPS.			
DATUM: WGS 84			
LATITUDE:	31.921889	LONGITUDE:	-95.922356
START DATE:	06/24/24	END DATE:	06/24/24
SURFACING:	Grass	WEATHER:	Sunny, 90's

DRILLER:	V. Burnham/D. Velasquez	LOGGED BY:	Q. Thomas
SURFACE ELEVATION:	362.0 ft	RIG:	75010
METHOD:	Solid Stem Auger		

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	q_p tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
361.7 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, brown	☒	3-3-3 (6)		5	29						
360.0 2.0		SILTY SAND (SM), fine-grained, brown, loose											
356.0 6.0		CLAYEY SAND (SC), fine-grained, light brown, loose *Reddish gray from 4 to 6 feet*	☒	2-2-3 (5)		15							
			☒	4-4-5 (9)		16	49	36	12	24			
342.0 20.0		LEAN CLAY (CL), little Sand, light brown to light gray, stiff to very stiff	☒	5-7-7 (14)		19							
			☒	6-6-9 (15)		17							
			■	SH	3.75	18		40	13	27	113	2.33	
			■	SH	2.50	15							
		END OF BORING Boring then backfilled with auger cuttings											

Water not observed while drilling.
Water not observed at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-04**
LOCATION:	Captured with RTK GPS.
DATUM:	WGS 84
LATITUDE:	31.920889
LONGITUDE:	-95.922583
DRILLER:	V. Burnham/D. Velasquez
LOGGED BY:	Q. Thomas
START DATE:	06/24/24
END DATE:	06/24/24
SURFACE ELEVATION:	368.1 ft
RIG:	75010
METHOD:	Solid Stem Auger
SURFACING:	Grass
WEATHER:	Sunny, 90's

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	qp tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
367.8 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, light brown	☒	3-3-4 (7)		5							
366.1 2.0		SILTY SAND (SM), fine-grained, light brown, loose											
		SANDY LEAN CLAY (CL), fine-grained, reddish brown, medium to very stiff	☒	3-3-5 (8)		16	52	36	14	22			
5			☒	7-8-9 (17)		18							
		Light brown from 6 to 13 feet	■	SH	2.75	17	68	41	13	28	112	2.31	
			■	SH	2.00	17							
10													
355.1 13.0		SILTY SAND (SM), fine-grained, reddish brown, medium dense *With Clay lenses from 13 to 15 feet*	☒	7-8-14 (22)		8							
15													
	▼		☒	8-8-10 (18)		9							
348.1 20.0		END OF BORING Boring then backfilled with auger cuttings											
25													

Water observed at 19.0 feet while drilling.
Water observed at 19.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-05**
LOCATION: Captured with RTK GPS.	
DATUM: WGS 84	
LATITUDE: 31.921637	LONGITUDE: -95.921486
START DATE: 06/24/24	END DATE: 06/24/24
SURFACING: Grass	WEATHER: Sunny, 90's

DRILLER: V. Burnham/D. Velasquez	LOGGED BY: Q. Thomas		
SURFACE ELEVATION: 360.5 ft	RIG: 75010	METHOD: Solid Stem Auger	

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)		Sample	Blows (Blows/ft) Recovery	q_p tsf	MC %	%Pass No. 200	Atterberg Limits			Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
									LL	PL	PI			
360.2 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, brown		☒	2-2-2 (4)		10	37						
358.5 2.0		SILTY SAND (SM), fine-grained, brown, very loose												
356.5 4.0		SILTY, CLAYEY SAND (SC-SM), fine-grained, brown, very loose		☒	1-1-1 (2)		12		18	12	6			
347.5 13.0	▽	SILTY SAND (SM), fine to coarse-grained, light brown, medium dense to dense *With Clay lenses from 6 to 8 feet*	5	☒	7-11-15 (26)		11							
	▼			☒	12-17-22 (39)		8	18						
			10	☒	12-17-12 (29)		9							
337.5 23.0		CLAYEY SAND (SC), fine-grained, light brown, medium dense	15	☒	5-5-6 (11)		10							
			20	☒	8-13-14 (27)		10							
335.5 25.0		SANDY LEAN CLAY (CL), little Sand, light gray, very stiff	25	☒	5-7-10 (17)		16		35	11	24			
		END OF BORING Boring then backfilled with auger cuttings												

Water observed at 5.0 feet while drilling.
Water observed at 6.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-06**		
LOCATION: Captured with RTK GPS.			
DATUM: WGS 84			
LATITUDE:	31.920703	LONGITUDE:	-95.921340
START DATE:	06/24/24	END DATE:	06/24/24
SURFACING:	Grass	WEATHER:	Sunny, 90's

DRILLER:	V. Burnham/D. Velasquez	LOGGED BY:	Q. Thomas		
SURFACE ELEVATION:	369.1 ft	RIG:	75010	METHOD:	Solid Stem Auger

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	qp tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
368.8 0.3		TOPSOIL, SANDY LEAN CLAY (CL), fine-grained, trace roots, light brown	☒	5-6-9 (15)		8							
		SANDY LEAN CLAY (CL), fine-grained, light brown, stiff	☒	5-5-5 (10)		10	51	28	11	17			
365.1 4.0	▽ ▼	SILTY SAND (SM), fine-grained, brown, very loose to medium dense	☒	3-3-1 (4)		12							
			☒	1-3-6 (9)		16							
			☒	7-11-15 (26)		10	33						
		With Clay lenses from 13 to 18 feet	☒	5-7-11 (18)		13							
		With Clay layers, reddish brown from 18 to 23 feet	☒	6-12-14 (26)		17							
346.1 23.0		CLAYEY SAND with GRAVEL (SC), fine to coarse-grained, light brown, very dense	☒	18-32-45 (77)									
344.1 25.0		END OF BORING Boring then backfilled with auger cuttings											

Water observed at 4.0 feet while drilling.
Water observed at 6.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-07**		
LOCATION: Captured with RTK GPS.			
DATUM: WGS 84			
LATITUDE:	31.921105	LONGITUDE:	-95.920315
START DATE:	06/25/24	END DATE:	06/25/24
SURFACING:	Grass	WEATHER:	Partly cloudy, 90's

DRILLER:	V. Burnham/D. Velasquez	LOGGED BY:	Q. Thomas		
SURFACE ELEVATION:	366.1 ft	RIG: 75010		METHOD:	Solid Stem Auger

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	q_p tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
365.8 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, brown	⊠	2-3-3 (6)		6							
362.1 4.0		SILTY SAND (SM), fine-grained, brown, very loose to loose *Light brown from 2 to 4 feet*	⊠	2-2-2 (4)		7	29						
358.1 8.0		CLAYEY SAND (SC), fine-grained, reddish brown, loose to medium dense	⊠	1-2-3 (5)									
			■	SH	2.50	15	49	28	14	14			
353.1 13.0	▽	SANDY LEAN CLAY (CL), reddish brown, very stiff	⊠	4-7-11 (18)		18		39	12	27			
341.7 24.5	▼	SILTY SAND (SM), fine-grained, reddish brown, medium dense to very dense	⊠	9-11-13 (24)		16							
		With little Gravel and Clay layers from 18 to 20 feet	⊠	7-11-19 (30)		19							
			⊠	22-50/6" (REF)		21							
		END OF BORING Boring then backfilled with auger cuttings											

Water observed at 13.0 feet while drilling.
Water observed at 14.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-08**
LOCATION: Captured with RTK GPS.	
DATUM: WGS 84	
LATITUDE: 31.921916	LONGITUDE: -95.920230
START DATE: 06/25/24	END DATE: 06/25/24
SURFACING: Grass	WEATHER: Partly cloudy, 90's

DRILLER: V. Burnham/D. Velasquez	LOGGED BY: Q. Thomas	
SURFACE ELEVATION: 363.0 ft	RIG: 75010	METHOD: Solid Stem Auger

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Depth	Sample	Blows (Blows/ft) Recovery	qp tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
362.6 0.4		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, light brown		☒	3-3-3 (6)		4							
		SILTY SAND (SM), fine-grained, light brown, very loose to medium dense		☒	2-1-1 (2)		6	18						
		With Clay lenses from 4 to 6 feet	5	☒	3-2-2 (4)		13							
		Reddish brown from 6 to 8 feet		☒	7-9-10 (19)		13							
355.0 8.0	▼	CLAYEY SAND (SC), fine-grained, reddish brown, medium dense to very dense	10	☒	10-10-10 (20)		12	18	24	16	8			
		With Clay layers from 13 to 15 feet *Light brown from 13 to 20 feet*	15	☒	6-26-50/4" (REF)		16							
			20	☒	12-12-9 (21)		13							
340.0 23.0		POORLY GRADED SAND with SILT (SP-SM), fine-grained, light gray, dense		☒	13-22-28 (50)		24							
338.0 25.0		END OF BORING Boring then backfilled with auger cuttings	25											

Water observed at 10.0 feet while drilling.
Water observed at 10.0 feet at end of drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING: **ST-09**
LOCATION: Captured with RTK GPS.
DATUM: WGS 84
LATITUDE: 31.921617
LONGITUDE: -95.919737
DRILLER: V. Burnham/D. Velasquez
LOGGED BY: Q. Thomas
START DATE: 06/25/24
END DATE: 06/25/24
SURFACE ELEVATION: 363.4 ft
RIG: 75010
METHOD: Solid Stem Auger
SURFACING: Grass
WEATHER: Partly cloudy, 90's

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	qp tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
363.1 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, brown	☒	2-1-2 (3)		4							
		SILTY SAND (SM), fine-grained, brown, very loose to loose	☒	2-1-1 (2)		9	25						
	▽		☒	2-4-6 (10)		14							
357.4 6.0	▼	CLAYEY SAND (SC), fine-grained, reddish brown to gray, medium dense to dense	■	SH	3.00	14	38	27	13	14			
			■	SH	3.00	14							
		With Gravel from 13 to 15 feet	☒	10-9-11 (20)		12							
			☒	7-14-18 (32)		8							
343.4 20.0		POORLY GRADED SAND with SILT (SP-SM), fine-grained, light gray, very dense	☒	18-32-50/4" (REF)		23							
338.5 24.8		END OF BORING Boring then backfilled with auger cuttings											

Water observed at 5.0 feet while drilling.
Water observed at 7.0 feet at end of drilling.

LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B2405335
Geotechnical Evaluation
Cayuga ISD
17750 N US HIghway 287
Bethel, Texas

BORING:	**ST-10**		
LOCATION: Captured with RTK GPS.			
DATUM: WGS 84			
LATITUDE:	31.920506	LONGITUDE:	-95.919945
START DATE:	06/25/24	END DATE:	06/25/24
SURFACING:	Grass	WEATHER:	Partly cloudy, 90's

DRILLER:	V. Burnham/D. Velasquez	LOGGED BY:	Q. Thomas		
SURFACE ELEVATION:	368.9 ft	RIG:	75010	METHOD:	Solid Stem Auger

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (Blows/ft) Recovery	qp tsf	MC %	%Pass No. 200	Atterberg Limits LL	PL	PI	Dry Unit Wt. pcf	Un. Com. Str. tsf	Tests or Remarks
368.6 0.3		TOPSOIL, SILTY SAND (SM), fine-grained, trace roots, brown	☒	1-1-1 (2)		10							
	▽	SILTY SAND (SM), fine-grained, brown, very loose *Light brown from 2 to 4 feet*	☒	WOH/18"		17							
364.9 4.0		SANDY LEAN CLAY (CL), reddish gray, medium to very stiff	☒	2-3-5 (8)		17	56	36	12	24			
	▼		☒	9-10-11 (21)		12							
			☒	7-15-13 (28)		10							
355.9 13.0		FAT CLAY (CH), trace Sand, with Silt lenses, light gray, stiff	☒	4-4-8 (12)		26		76	20	56			
350.9 18.0		SILTY SAND (SM), fine-grained, light brown, medium dense	☒	10-8-8 (16)		12							
345.9 23.0		POORLY GRADED SAND with SILT and GRAVEL (SP-SM), coarse-grained, with Clay lenses, light brown, very dense	☒	7-18-32 (50)		13							
343.9 25.0		END OF BORING Boring then backfilled with auger cuttings											

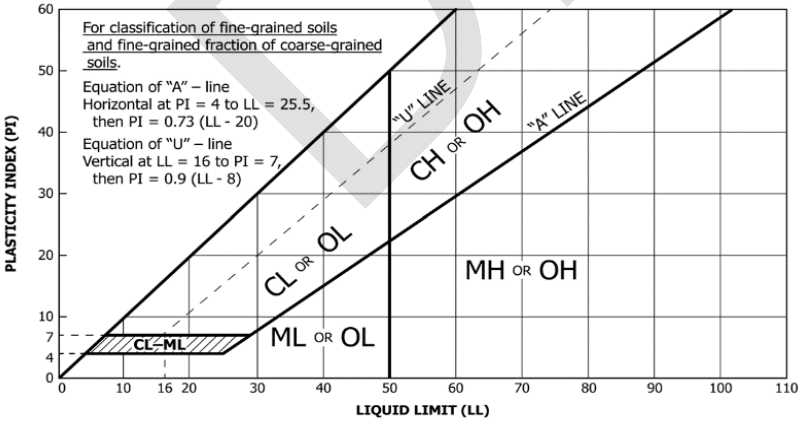
Water observed at 3.0 feet while drilling.
Water observed at 6.0 feet at end of drilling.

Descriptive Terminology of Soil

Based on Standards ASTM D2487/2488
(Unified Soil Classification System)

<table>
<tr><th colspan="5" rowspan="2">Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]</th><th colspan="2">Soil Classification</th></tr>
<tr><th>Group Symbol</th><th>Group Name[B]</th></tr>
<tr><td rowspan="8">Coarse-grained Soils (more than 50% retained on No. 200 sieve)</td><td rowspan="4">Gravels (More than 50% of coarse fraction retained on No. 4 sieve)</td><td rowspan="2">Clean Gravels (Less than 5% fines[C])</td><td colspan="2">$C_u \geq 4$ and $1 \leq C_c \leq 3$[D]</td><td>GW</td><td>Well-graded gravel[E]</td></tr>
<tr><td colspan="2">$C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D]</td><td>GP</td><td>Poorly graded gravel[E]</td></tr>
<tr><td rowspan="2">Gravels with Fines (More than 12% fines[C])</td><td colspan="2">Fines classify as ML or MH</td><td>GM</td><td>Silty gravel[E F G]</td></tr>
<tr><td colspan="2">Fines Classify as CL or CH</td><td>GC</td><td>Clayey gravel[E F G]</td></tr>
<tr><td rowspan="4">Sands (50% or more coarse fraction passes No. 4 sieve)</td><td rowspan="2">Clean Sands (Less than 5% fines[H])</td><td colspan="2">$C_u \geq 6$ and $1 \leq C_c \leq 3$[D]</td><td>SW</td><td>Well-graded sand[I]</td></tr>
<tr><td colspan="2">$C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D]</td><td>SP</td><td>Poorly graded sand[I]</td></tr>
<tr><td rowspan="2">Sands with Fines (More than 12% fines[H])</td><td colspan="2">Fines classify as ML or MH</td><td>SM</td><td>Silty sand[F G I]</td></tr>
<tr><td colspan="2">Fines classify as CL or CH</td><td>SC</td><td>Clayey sand[F G I]</td></tr>
<tr><td rowspan="6">Fine-grained Soils (50% or more passes the No. 200 sieve)</td><td rowspan="3">Silts and Clays (Liquid limit less than 50)</td><td rowspan="2">Inorganic</td><td colspan="2">PI > 7 and plots on or above "A" line[J]</td><td>CL</td><td>Lean clay[K L M]</td></tr>
<tr><td colspan="2">PI < 4 or plots below "A" line[J]</td><td>ML</td><td>Silt[K L M]</td></tr>
<tr><td>Organic</td><td colspan="2">$\frac{\text{Liquid Limit – oven dried}}{\text{Liquid Limit – not dried}} < 0.75$</td><td>OL</td><td>Organic clay [K L M N]
Organic silt [K L M O]</td></tr>
<tr><td rowspan="3">Silts and Clays (Liquid limit 50 or more)</td><td rowspan="2">Inorganic</td><td colspan="2">PI plots on or above "A" line</td><td>CH</td><td>Fat clay[K L M]</td></tr>
<tr><td colspan="2">PI plots below "A" line</td><td>MH</td><td>Elastic silt[K L M]</td></tr>
<tr><td>Organic</td><td colspan="2">$\frac{\text{Liquid Limit – oven dried}}{\text{Liquid Limit – not dried}} < 0.75$</td><td>OH</td><td>Organic clay [K L M P]
Organic silt [K L M Q]</td></tr>
<tr><td colspan="2">Highly Organic Soils</td><td colspan="3">Primarily organic matter, dark in color, and organic odor</td><td>PT</td><td>Peat</td></tr>
</table>

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. $C_u = D_{60} / D_{10}$ $\qquad C_c = (D_{30})^2 / (D_{10} \, x \, D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
G. If fines are organic, add "with organic fines" to group name.
H. 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
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
L. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N. PI ≥ 4 and plots on or above "A" line.
O. PI < 4 or plots below "A" line.
P. PI plots on or above "A" line.
Q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	q_p	Pocket penetrometer strength, tsf
WD	Wet density, pcf	q_U	Unconfined compression test, tsf
P200	% Passing #200 sieve	**LL**	Liquid limit
MC	Moisture content, %	**PL**	Plastic limit
OC	Organic content, %	**PI**	Plasticity index

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3" (19.00 mm to 75.00 mm)
Fine	No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand	
Coarse	No. 10 to No. 4 (2.00 mm to 4.75 mm)
Medium	No. 40 to No. 10 (0.425 mm to 2.00 mm)
Fine	No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt	No. 200 (0.075 mm) to .005 mm
Clay	< .005 mm

Relative Proportions[L, M]

trace	0 to 5%
little	6 to 14%
with	≥ 15%

Inclusion Thicknesses

lens	0 to 1/8"
seam	1/8" to 1"
layer	over 1"

Apparent Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils	**Blows Per Foot**	**Approximate Unconfined Compressive Strength**
Very soft	0 to 1 BPF	< 0.25 tsf
Soft	2 to 4 BPF	0.25 to 0.5 tsf
Medium	5 to 8 BPF	0.5 to 1 tsf
Stiff	9 to 15 BPF	1 to 2 tsf
Very Stiff	16 to 30 BPF	2 to 4 tsf
Hard	over 30 BPF	> 4 tsf

Moisture Content:

Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp but no visible water.
Wet: Visible free water, usually soil is below water table.

Drilling Notes:

Blows/N-value: Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

Partial Penetration: If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

Recovery: Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

WOH: Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WOR: Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

Water Level: Indicates the water level measured by the drillers either while drilling (▽), at the end of drilling (▼), or at some time after drilling (⧩).

Sample Symbols

☒	Standard Penetration Test	▮	Rock Core
⧗	Modified California (MC)	■	Thinwall (TW)/Shelby Tube (SH)
▮	Auger	▽	Texas Cone Penetrometer
✋	Grab Sample	▽	Dynamic Cone Penetrometer