TSI LABORATORIES, INC.

GEOTECHNICAL ENGINEERING STUDY

Matagorda County JP Office
Matagorda County, TX

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August 15, 2025

Mitchell Carrillo
Lynn Engineering
2200 Ave. A
Bay City, TX 77414

Subject: Matagorda County JP Office
Matagorda County, TX

TSI File No.: G-251175

Dear Mr. Carrillo,

We are pleased to submit this report on our geotechnical engineering study for the Matagorda County JP Office located at the intersection of Center St. and Magnolia St. in Matagorda County, TX. The findings and a description of the exploration and testing procedures are presented in the report along with our site preparation recommendations.

We appreciate the opportunity to assist in this phase of the project. Please feel free to contact us if you have any questions regarding this report or if we may be of further service.

Respectfully submitted,

TSI Laboratories, Inc.

DANIEL TESFAI
93944

Michael Tater

Daniel Tesfai

Michael Tater, President.

Daniel Tesfai, P.E.

GEOTECHNICAL ENGINEERING STUDY

Matagorda County JP Office
Matagorda County, TX

Prepared For:

Mitchell Carrillo
Lynn Engineering

Prepared By:

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INTRODUCTION

Authorization and Scope

TSI Laboratories, Inc. (TSI) was retained to provide geotechnical study services by Mitchell Carrillo with Lynn Engineering. The purpose of this study was to determine and evaluate the stratification and engineering properties of the site subsurface soils. TSI will also provide geotechnical engineering recommendations and guidelines for use in site preparation, foundation design, building pad, and related site improvements planned for the Matagorda County JP Office located at the intersection of Center Street and Magnolia Street in Matagorda County, Texas.

Project Description

The proposed project involves the construction of a 7,200 square foot, one-story, pre-engineered metal frame building with the associated paving. Based on the results of the study, this structure could be supported by any of the following foundation systems; slab-on-grade, spread footing or drilled piers foundation.

FIELD AND LABORATORY TESTING

Field Testing

The site soil was explored by drilling two (2) 25-foot-deep borings. The number of borings, depths, and locations were determined by the client. Soil was sampled continuously at 2-foot intervals to 10-foot depth with an additional sample taken at 5-foot depth intervals. The sampling method is determined based on the encountered soils.

Cohesive soils were sampled by hydraulically pushing a 3-inch diameter, thin-walled steel tube about 24-inches. Our field sampling procedures were in general accordance with ASTM D1587. For each recovered sample, our representative extruded the sample in the field, visually classified the soil, and measured the penetration resistance using a pocket penetrometer. A portion of the recovered sample was placed into a sample container and transported to our laboratory for testing.

Laboratory Testing

The soil samples selected for laboratory testing were examined and visually classified by the sample's representative of the various soil strata encountered. Atterberg limits, moisture contents and percent fines tests were performed to assist in classifying the soils according to Unified Soil Classification System (ASTM D2487). Unconfined compressive strength tests were also performed to provide indicators of soil strength. The classification test results are presented on boring logs. The test procedures are described in the Appendix.

SUBSURFACE CONDITIONS

The test borings encountered fat and lean clay (CH/CL) soils to the boring termination depths. The site soil has been evaluated by performing various field and laboratory tests on the subsurface samples recovered during the drilling operations. The types of tests conducted on the subsurface samples and the results of the tests are tabulated on the Log of Borings, which are provided in the Appendix. The properties of each stratum are discussed below.

The corresponding log of borings, depicting the stratum soil descriptions, type of sampling used during sample retrieval, laboratory test data, and other field data, is presented in the Appendix at the end of this report. The key to boring log symbols and soil classifications sheet, which defines the terms and descriptive symbols used on each boring log, is also presented in the Appendix.

Groundwater

Groundwater was encountered at 13 and 13.5-feet depths during our drilling operations. It is noted that groundwater levels fluctuate with seasonal climatic variations, such as rainfall, runoff, and other factors. The possibility of groundwater level fluctuations should be considered when developing the design and construction for the project.

EVALUATION

General

Based on the laboratory tests performed, the soils encountered at this site generally exhibit a medium to high potential for expansion. Based on the results of our field and laboratory testing, the clayey strata underlying this site consists of soft to hard soils that are competent to support the loadings from the structure with necessary site preparation and compaction.

Potential Vertical Rise (PVR)

Potential vertical soil movements were estimated using the Texas Department of Transportation method TEX-124-E, Potential Vertical Rise. This method utilizes the soil's in-situ moisture conditions and plasticity characteristics within the active zone. It is estimated that the depth of the active zone at this site is approximately 15-feet. The estimated Potential Vertical Rise (PVR) values for the dry and average moisture conditions of subgrade soils are **2.50 and 1.75 inches, respectively**. A sustained surcharge load of one (1) pound per square inch is assumed to be imposed by the floor and sustained live load in the PVR calculations. It is noted that the PVR estimates are provided as an indicator of the severity of potential soil movements at this site and are not intended as a prediction of actual foundation movements.

Structural engineers typically consider a PVR of 1-inch as the maximum permissible soil movement and a differential settlement of approximately ¾-inch. A PVR less than 1-inch does not mean that the movement is eliminated. It only means that the foundation can be designed for this amount of soil movement. An anticipated settlement of less than 1-inch is expected during the service life of the structure taking into consideration for the site preparation involving removal of native high plasticity clays
and replacement with select structural fill.

RECOMMENDATIONS

Our recommendations are based on knowledge of the area; however, the project design team should specify actual construction requirements. The final selection of foundation for the building should be based on considerations of several factors, such as 1) function of the structure, 2) soil strength properties, expansive soil properties, and settlement characteristics of subsurface materials; 3) the magnitude of applied structural loads; and 4) construction costs.

Site Preparation

Site preparation should consist initially of, (a) clearing and the stripping of any vegetation and roots, and (b) removing any materials containing significant organic material from the foundation footprints. Soils having more than 10% by volume are considered to have organic material. The exposed subgrade surfaces (c) should then be proof rolled with a loaded heavy earthwork piece of machinery such as a motorized articulated scraper, maintainer, or dump truck to detect soft or loose zones, followed by proper soil replacement if necessary and then (d) scarified to at least 9-inches; moisture conditioned within 2% wet of optimum moisture and compacted to a minimum of 95% of maximum dry density determined by ASTM D698 (Standard Proctor).

Selection and Placement of Fill

Structural fill should be low plasticity sandy clays or imported caliche sand and gravel. Recommended fill specifications are included in the appendix, and these may be used as a guide for the placement of fill and for pavement construction. Particular attention should be given to maintaining the proper moisture content during compaction to prevent the fill from drying before subsequent lifts are placed.

Construction areas should be stripped of vegetation and root structure, and the exposed subgrade should be proof rolled with appropriate construction equipment weighing at least 20-tons. The purpose of this recommendation is to check the subgrade for weak or soft areas prior to fill placement and compaction. This operation should be observed and evaluated by qualified TSI personnel experienced in earthwork operations.

If weak or soft areas are observed during proof rolling operations, the soil in the subject area should be removed to expose competent subgrade soils in both horizontal and vertical limits. The excavated soils provided they are not contaminated with deleterious materials, or clean imported fill soils can be used to restore grade at these isolated areas; any imported fill should meet the requirements for select fill. Placement and compaction of the soils are discussed below.

Select fill within paving areas should consist of lean clay or sandy lean clay, free of roots, organics, and deleterious materials. The select fill should have at least 50% passing the No. 200 sieve and have a PI between 8 and 18. Representative samples of the fill materials should be tested to confirm their material characteristics prior to the filling operations.

Subgrade areas should be scarified to a depth of about 9-inches and moisture adjusted within 2% of the optimum moisture content. The moisture-conditioned subgrade should then be compacted to at least 95% of maximum dry density determined in accordance with ASTM D698. The subgrade should be moisture conditioned just prior to fill placement in order that the subgrade maintains its compaction moisture levels and does not dry out.

Structural fill (fill that provides load-bearing support) should consist of select fill placed on prepared surfaces in lifts not to exceed 8-inches loose measure, with compacted thickness not to exceed 6-inches. All structural fill should be moisture conditioned to within 2% of optimum moisture content and then compacted to at least 95% of maximum dry density as evaluated by ASTM D698. A testing frequency of one in-place density and moisture test for each 2,500 sf or less should be considered, with a minimum of three tests.

Foundation Systems

Slab-on-Grade

The lightweight structure at this site may be supported on conventionally reinforced slab-on-grade foundation systems provided the subgrade and pad are prepared in accordance with the recommendations contained herein.

The corresponding decrease in the potential soil movements is primarily a function of the fill pad thickness and the moisture levels of the underlying clayey subgrade. While the recommended preparations do not eliminate the potential for soil movement, the magnitude of such movements should be reduced to more acceptable levels. We recommend the slab-on-grade for the structure be supported by removing 4-feet of the fat clay soils and replacing them with properly placed and compacted select fill soils. The select fill pad should also extend horizontally a minimum distance of 2-feet beyond the edge of the slab area.

Select fill should be utilized for all grade adjustments within the proposed slab area. Furthermore, we recommend that the finished floor elevation of the structure be above the final exterior grade and adjacent grades be sloped to produce positive drainage away from the building and pad.

The subgrade soils and select fill building pad soils should be prepared as outlined in the “Earthwork” section of this report, which contains material and placement requirements for select fill, as well as other subgrade preparation recommendations. The slab-on-grade foundation may be designed using the following parameters provided the subgrade is prepared as discussed above.

Slab-on-grade floor slabs may be designed for an allowable bearing pressure of **1,800 psf** based on total loads which includes a safety factor of two (2). A subgrade modulus of 100 pci may be used in design.

Spread Footings

Concentrated structural loads can be supported by spread footings. Spread footings should be founded a minimum of **4-feet below the existing grade**. If spread footings are placed in an area where existing soils have been removed and replaced with select fill, spread footings should be founded below the bottom of the select fill layer but in no case, shallower than 4-feet. Spread footings founded at or below the 4-feet depth may be designed for a net total load bearing pressure of **3.9 ksf.** These bearing pressures are based on factors of safety against bearing capacity failure of approximately 2.

Pier Design Parameters

Parameter	Recommendation	Comments
Foundation Type	Drilled Piers	Limit underream diameter to 96 inches
Bearing Depth, feet	18	Measured below the existing grade
Bearing Material	CL	------
Net Allowable Bearing Pressure*, q_{all}	4.8.kips/ft^2	Includes factor of safety (F.S.) of 3
Pier Spacing	At least two underream diameters or 5 to 10 shaft diameters	Measured center-to-center
Allowable Lateral Resistance, $q_{lateral}$	1.5 kips/ft^2	Neglect upper 4 ft, F.S. of 2
Estimated uplift pressure due to post-construction heave of the clay soils	650 psf	approximated over the entire perimeter of the shaft above the top of the underream
Allowable Uplift of Resistance, kips	$2.2(D^2-d^2) +0.8$ Wc	D – Underream diameter, ft d – Shaft diameter, ft Wc – Effective weight of concrete, kips
Bell-to-Shaft Ratio	2:1 to 2.5:1	Straight sided if sloughing is encountered
Pier Reinforcement	Minimum of 0.5% of concrete area	Extend the full depth of shaft and underream

NOTE: * May be increased 33% for transient loading conditions such as wind

The shafts of the drilled piers will be subjected to tension (uplift) forces induced by the soil when they undergo expansion. The piers should be reinforced with sufficient vertical reinforcing steel from the top of the shaft to the bottom to resist this potential uplift force from the swelling clays.

Settlement Considerations

Total settlements, based on the indicated bearing pressures, should be about 1-inch or less for properly designed and constructed drilled piers. Settlement beneath individual piers will be primarily elastic with most of the settlement occurring during construction. Differential settlement may also occur between adjacent piers. The amount of differential settlement could approach 50 to 75% of the total pier settlement. For properly designed and constructed piers, differential settlement between adjacent piers is estimated to be less than ¾-inch. Settlement response of drilled piers is impacted more by the quality of construction than by soil structure interaction.

Improper pier installation could result in differential settlements significantly greater than we have estimated. In addition, larger magnitudes of settlement should be expected if the soil is subjected to bearing pressures higher than the allowable values presented in this report.

Foundation Construction

After initial site stripping, we recommend the exposed soils to be thoroughly proof rolled with a 20-ton pneumatic roller or loaded dump truck. Soft/weak areas detected during the proof rolling activities should be removed and replaced with properly compacted select fill soils. The select fill beneath the floor slab should be prepared as outlined in the previous section of this report. This over-excavation, proof rolling, and additional fill placement should be observed by TSI to evaluate the integrity of the fill soils for proper support of the at-grade floor slab of the building.

The excavations for the shallow footing foundation system should be performed with equipment capable of providing a relatively clean bearing area. The bottom 6-inches on the planned foundation excavations should be completed with a smooth-mouthed bucket or by hand labor. The excavations should be neatly excavated and properly formed. The soil subgrade at the base of each footing should be evaluated following completion of the excavation and immediately prior to placing the concrete. Debris at the bottom of the excavation should be removed prior to steel placement. Water should not be allowed to accumulate at the bottom of the foundation excavation. To reduce the potential for water infiltration into the excavations and to minimize disturbance to the bearing area, we recommend that steel and concrete be placed as soon as possible after the excavations are completed and properly cleaned. A seal slab (2 to 4-inches) should be placed within the footing bearing area for footings that will not be backfilled with concrete within 48-hours of the footing excavation.

Grade Beams

Exterior (or turned down edges) and interior grade beams should be used to support concentrated loads and to stiffen the floor slab. The depth of exterior and interior grade beams can be varied according to the structural requirements of the floor slab. We recommend exterior grade beams and interior beams be supported at least **24-inches and 20-inches below the finished grade**, respectively. Exterior and interior grade beams may be designed using an allowable net bearing pressure of **1,800 psf** for total loading conditions.

The width of the grade beam should be designed such that the vertical pressure applied to the soil does not exceed the recommended bearing pressure. In any case, the width of the grade beam should be at least 16-inches to facilitate placement of the reinforcing steel, and cleaning and observing the excavation bottom prior to placement of the concrete. We do not recommend the use of void boxes below grade beams because of the potential to collect free water within the void space. Grade beams will also act as moisture barriers, reducing moisture fluctuations beneath the slab. Deeper moisture barriers will provide better control of moisture fluctuations particularly during extended periods of dry or wet weather.

Foundation Construction Monitoring

The performance of the recommended foundation systems for the proposed structure will be highly dependent upon the quality of construction. Thus, we recommend that building pad compaction and foundation installation be monitored full-time by an experienced TSI soil technician under the direction of our geotechnical engineer.

Earthwork

Construction areas should be stripped of all vegetation including roots, loose/soft topsoil, and other unsuitable surface materials. Following stripping and prior to placement of additional fill, the exposed soil subgrade areas should be proof rolled with a 20-ton pneumatic roller or a loaded dump truck to detect weak areas. Weak areas detected during proof rolling should be removed and replaced with select fill. Proper site drainage should be maintained during construction, so that ponding of surface runoff does not occur and causes construction delays and/or inhibits site access.

After proof rolling, and just prior to placement of fill, the exposed subgrade should be evaluated for moisture and density. The subgrade should be within 2% of the optimum moisture content and have an in-place dry density of at least 95% of the Standard Effort (ASTM D698) maximum dry density of the in-situ soils. If the moisture or density does not meet the above criteria, the subgrade should be scarified to a minimum depth of 9-inches, moisture adjusted to within 2% of the optimum moisture content and compacted to at least 95% of the Standard Effort (ASTM D698) maximum dry density.

Grade adjustments within the building pad area should be accomplished with select fill composed of clean lean clay, sandy lean clay, or clayey sand soils with a plasticity index ranging between 8 and 18. Select fill should be placed on prepared surfaces in lifts not to exceed 8-inches loose measure, with compacted thickness not to exceed 6-inches. The select fill should be compacted to at least 95% of the Standard Effort (ASTM D698) maximum dry density within 2% of the optimum moisture content.

If imported blended or mixed soils are intended for use to construct the building pad, TSI should be contacted to provide additional recommendations accordingly. Blended or mixed soil does not occur naturally. These soils are a blend of sand and clay and will require mechanical mixing at the site. If these soils are not mixed thoroughly to break down the clay clods and blend-in the sand to produce a uniform soil matrix, the fill material may be detrimental to the slab performance. If blended soils are used, we recommend that additional samples of the blended soils, as well as the clay clods, be obtained prior to and during earthwork operations to determine if the blended soils can be used in lieu of select fill.

A qualified soil technician should perform sufficient in-place density tests during the filling operations to evaluate those proper levels of compaction, including dry unit weight and moisture content, are being attained.

Wet Weather/Soft Subgrade Considerations

Construction during and soon after wet weather periods may encounter difficulties due to wet surficial soils becoming a general hindrance to equipment due to rutting and/or pumping of the soil's surface. If the subgrade cannot be adequately compacted to the minimum densities, one of the following methods should be used to improve the soil: 1) removal and replacement with select fill, 2) chemical treatment of the soil to dry the subgrade, or 3) drying by natural means if the schedule allows.

In our experience with similar soils in this area, chemical treatment is the most efficient and effective method to increase the supporting value of wet and soft subgrade. TSI should be contacted for additional recommendations if chemical treatment of the soil is needed due to the presence of wet and soft subgrade.

Drainage

All grades must provide effective drainage away from the building during and after construction. Water permitted to pond next to the building can result in greater soil movements than discussed in the report, and can result in unacceptable differential floor slab movement, cracked slab and walls, and roof leaks. Estimated movements and settlements described in this report are based on effective drainage for the life of the building and cannot be relied upon if effective drainage is not maintained.

Exposed ground should be sloped away from the building for at least 10-feet beyond the perimeter of the building. After construction and landscaping, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the building should also be periodically inspected and adjusted, as necessary.

Flatwork will be subject to post construction movement. Maximum grades practical should be used for flatwork to prevent water from ponding. Allowance in final grades should also consider post-construction movement of flatwork, particularly if such movement would be critical. Where flatwork abuts the building, effectively seal, and maintain joints to prevent surface water infiltration.

PAVEMENT DESIGN RECOMMENDATIONS

We anticipate that the pavement subgrade will consist of medium to high plasticity, surficial soils. We recommend that the top 6 to 8-inches of the finished subgrade soils directly beneath the pavement be chemically treated. Chemical treatment will increase the supporting value of the subgrade and decrease the effect of moisture on subgrade soils. These 6 to 8-inches of treatment are a required part of the pavement design and are not a part of site and subgrade preparation for wet/soft subgrade conditions.

Once the subgrade is properly prepared both flexible pavement systems (consisting of asphalt and base material) and reinforced concrete pavement systems may be considered for this project. Detailed traffic loads and frequencies were not available. However, we anticipate that traffic will consist primarily of passenger vehicles in the parking areas and large multi-axle delivery trucks in the driveways.

Tabulated in the following table are the assumed traffic frequencies and loads used to design pavement sections for this project.

PAVEMENT AREA	TDI*	DESCRIPTION
Automobile Parking Areas	DI-1	Light traffic (Few vehicles heavier than passenger cars, no regular use by heavily loaded two axle trucks or buses). (ESAL (1) < 6)
Driveways (Supporting Automobile Parking Areas)	DI-2	Medium to light traffic (Similar to DI-1 including not over 50 loaded two axle trucks or lightly loaded larger vehicles per day. No regular use by heavily loaded trucks or buses with three or more axles). (ESAL = 6-20)
Driveways and Light Truck Traffic Areas	DI-3	Medium traffic (Including not over 300 heavily loaded two axle trucks plus lightly loaded trucks with three or more axles and no more than 30 heavily loaded trucks or buses with more than three axles per day). (ESAL = 21-75)
Medium-Heavy Truck Traffic Areas	DI-4	Medium to Heavy Truck Traffic – Including not over 900 two axle trucks plus lightly loaded trucks or buses with three or more axles and no more than 60 heavily loaded trucks with more than three axles per day. (ESAL = 76 – 250)

(1) Equivalent daily 18-kip single-axle load applications.
*Traffic Design Index

Listed below are pavement component thicknesses, which may be used as a guide for pavement systems at the site for the traffic classifications stated herein. These systems were derived based on general characterization of the subgrade. Specific testing (such as CBR tests, resilient modulus tests, etc.) was not performed for this project to evaluate the support characteristics of the subgrade.

RIGID PAVEMENT SYSTEM				
COMPONENT	**Material Thickness, Inches**			
	DI-1	**DI-2**	**DI-3**	**DI-4**
Reinforced Concrete	5.0	6.0	8.0	9.0
Treated Subgrade	6.0	6.0	8.0	8.0

FLEXIBLE PAVEMENT SYSTEM				
COMPONENT	**Material Thickness, Inches**			
	DI-1	**DI-2**	**DI-3**	**DI-4**
Asphaltic Concrete	2.0	2.5	2.5	3.0
Base Material	8.0	10.0	12.0	14.0
Treated Subgrade	6.0	6.0	8.0	8.0

The pavement design engineer should consider these and other similar situations when planning and designing pavement areas. Waste bin and other areas that are not designed to accommodate these situations often result in localized pavement failures. Presented below are our recommended material requirements for the various pavement sections.

Reinforced Concrete Pavement – The materials and properties of reinforced concrete pavement shall meet applicable requirements in the ACI Manual of Concrete Practice. The Portland cement concrete mix should have a minimum 28-day compressive strength of 4,000 psi.

Reinforcing Steel – Reinforcing steel should consist of the following:

DI-1: #3 bars spaced at 18-inches, or #4 bars spaced at 24-inches on centers in both directions
DI-2: #3 bars spaced at 12-inches, or #4 bars spaced at 18-inches on centers in both directions
DI-3: #4 bars spaced at 18-inches on centers in both directions
DI-4: #4 bars spaced at 12-inches on centers in both directions

Control Joint Spacing – ACI recommendations indicate that control joints should be spaced at about 30-times the thickness of the concrete pavement. Furthermore, ACI recommends a maximum control joint spacing of 12.5-feet for 5-inch-thick pavements and a maximum control joint spacing of 15-feet for 6-inch or thicker pavements. Sawcut control joints should be cut within 6 to 12 hours of concrete placement.

Expansion Joint Spacing – ACI recommendations indicate that regularly spaced expansion joints may be deleted from concrete pavements. Therefore, the installation of expansion joints is optional and should be evaluated by the design team.

Dowels at Expansion Joints – The dowels at expansion joints, if the joints are provided, should be spaced at 12-inch centers, and consist of the following:

DI-1: 5/8-inch diameter, 12-inch long with 5-inch embedment

DI-2: 3/4-inch diameter, 14-inch long with 6-inch embedment
DI-3: 7/8-inch diameter, 14-inch long with 6-inch embedment
DI-4: 1-inch diameter, 14-inch long with 6-inch embedment

Hot Mix Asphaltic Concrete Surface Course – The asphaltic concrete surface course should be plant mixed, hot laid Type D (Fine Graded Surface Course) meeting the specifications requirements in TxDOT 2004 Standard Specifications Item 340. Specific criteria for the job specifications should include compaction to within an air void range of 5 to 9% calculated using the maximum theoretical gravity mix measured by TxDOT Tex-227-F. The asphalt cement content by percent of total mixture weight should be within ± 0.5% asphalt cement from the job mix design.

Base Material – Base material should be composed of crushed limestone or crushed concrete meeting the requirements of TxDOT 2004 Standard Specifications Item 247, Type A, B, or D, Grade 1. The base material should be compacted to at least 95% of the Modified Effort (ASTM D1557) maximum dry density at a moisture content within 2% of the optimum moisture content.

Treated Subgrade –The on-site surficial subgrade soils should be treated with lime in accordance with the TxDOT 2014 Standard Specifications Item 260. We recommend that 6 to 7% lime by dry weight be used for estimating and planning. The actual quantity of the lime should be determined at the time of construction based on laboratory, Atterberg-Lime Series, testing conducted using bulk samples of the subgrade soils. The pulverization, mixing and curing of the lime treated subgrade is of particular importance in these plastic clays. The lime used should be lime or commercial lime slurry conforming to TxDOT 2014 Standard Specifications Item 260.

The subgrade should be compacted to a minimum of 95% of the Standard Effort (ASTM D698) maximum dry density at a moisture content within 2% of optimum. Traffic should be kept off the treated subgrade for about 7 days to facilitate curing of soil - chemical mixture. In addition, the subgrade is not suitable for heavy construction traffic prior to paving.

Prior to compaction the following gradation requirement must be met:

Minimum passing percentage		
Sieve	**Base**	**Subgrade**
1¾	100 %	100 %
¾	85 %	85 %
#4	-	60 %

The pavement design methods described above are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The support characteristics of the subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade. Thus, the pavement may be adequate from a structural standpoint yet still experience cracking and deformation due to shrink/swell related movement of the subgrade. Post-construction subgrade movements and some cracking of pavements are not uncommon for clayey subgrade conditions such as those observed at this site. Minimizing moisture changes in the subgrade is important to reduce shrink/swell movements. Although lime treatment will help to reduce such movement/cracking this movement/cracking cannot be economically eliminated.

Related civil design factors such as subgrade drainage, shoulder support, cross-sectional configurations, surface elevations and environmental factors which will significantly affect the service life must be included in the preparation of the construction drawings and specifications. Normal periodic maintenance will be required.

Long-term pavement performance will be dependent upon several factors, including maintaining subgrade moisture levels and providing for preventive maintenance. The following recommendations should be implemented to help promote long-term pavement performance.

- Site grading should be designed to drain away from the pavements, preferably at a minimum grade of 2%.
- The subgrade and the pavement surface should be designed to promote proper surface drainage, preferably at a minimum grade of 2%.
- Joint sealant should be installed, and cracks should be sealed immediately.
- Curbs should be extended into the treated subgrade for a depth of at least 4-inches to help prevent moisture migration into the subgrade soils beneath the pavement section.
- Compacted, low permeability clayey backfill should be placed against the exterior side of the curb and gutter.

Preventive maintenance should be planned and provided for the pavements at this site. Preventive maintenance activities are intended to slow the rate of pavement deterioration and consist of both localized maintenance (e.g., crack, and joint sealing and patching) and global maintenance (e.g., surface sealing). Prior to implementing any maintenance, additional engineering observations are recommended to evaluate the type and extent of preventive maintenance needed.

Rolling Pattern

A minimum compaction temperature of 175°F (80°C) is the cutoff point, because after this point, the mat temperature is so low that compaction possibilities decrease rapidly. In some cases, the material is too hot to be properly compacted. This is noticeable from the instability of the material under the roller. It is essential that the first pass be made as soon as possible so that the temperature relationships mentioned above will be maintained. The greatest part of compaction is attained with the first breakdown pass. To eliminate or minimize compactor marks the final finishing passes may have to be delayed until the mat cools to the proper temperature.

Weather Limitations

Adverse weather conditions would affect the quality of the asphaltic concrete pavement. These include, but are not limited to the following:

1. Frozen subgrade as evident by the fact that a shaded surface thermometer reads 32°F or less, or the subgrade is excessively hard; the entrapped water has turned to ice.
2. For thin lifts temperature requirements such as 80°F.
3. Muddy subgrade due to the material being too wet.
4. Standing water on the subgrade (this can usually be remedied by using pumps and/or an air hose).
5. A light rain is sometimes OK if the mat does not cool down too quickly.

GENERAL COMMENTS

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

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

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials, or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

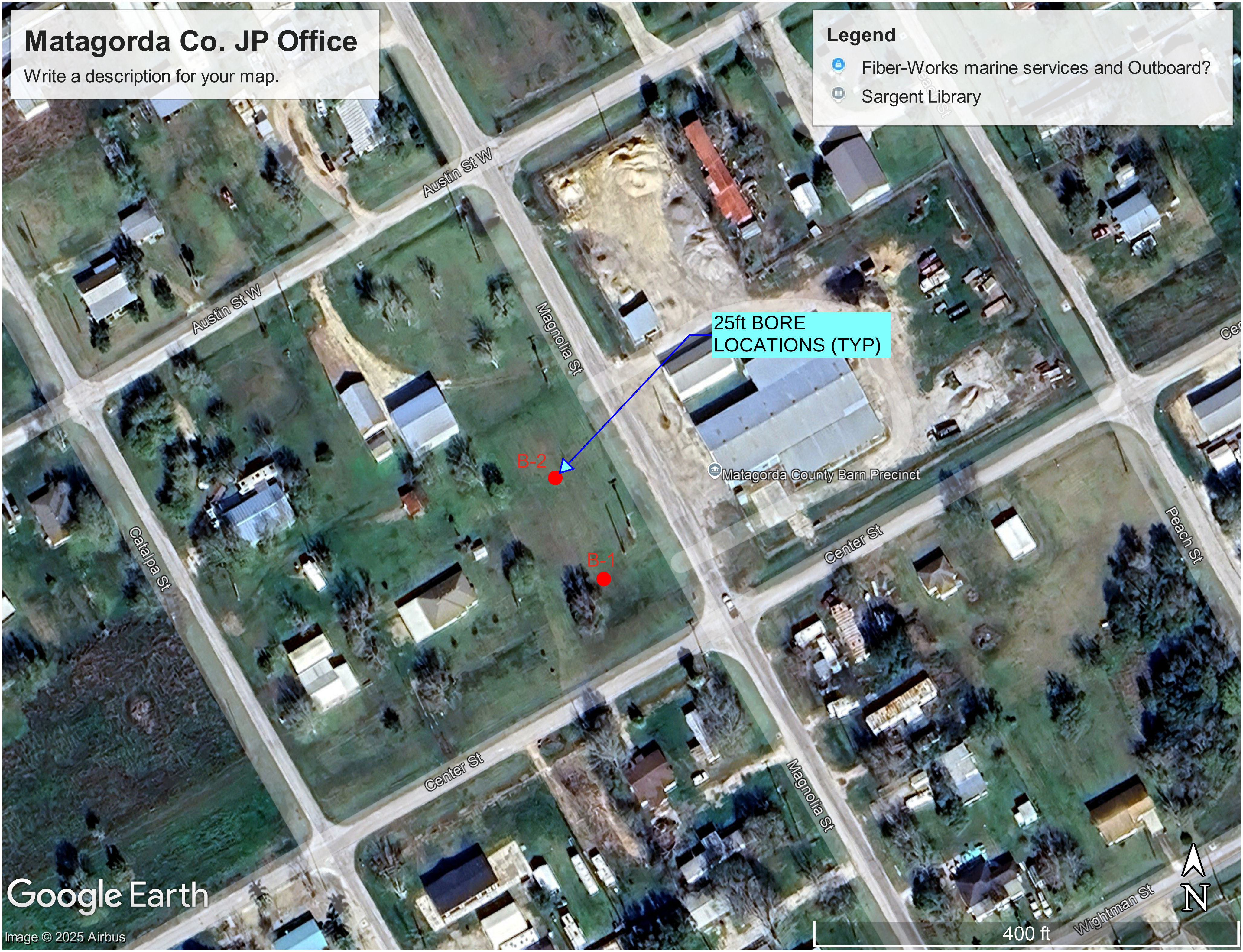
For any excavation construction activities at this site, all Occupational Safety and Health Administration (OSHA) guidelines and directives should be followed by the Contractor during construction to ensure a safe working environment. Regarding worker safety, OSHA Safety and Health Standards require the protection of workers from excavation instability in trench situations.

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

APPENDIX

Matagorda Co. JP Office

Write a description for your map.



25ft BORE LOCATIONS (TYP)

Image © 2025 Airbus

Log of Boring

PROJECT: Matagorda County JP Office
Magnolia Street & Center St.
Matagorda, TX 77457

CLIENT: Lynn Engineering

BORING NO.: B-1
LAB NO.: G-251175
DATE: 07
SURFACE ELEV.:

DRILLING METHOD(S) : Dry Auger 0-25.0'

GROUNDWATER INFORMATION:
Groundwater was encountered at 13.0'

FIELD DATA				LABORATORY DATA								
DEPTH (FEET)	SAMPLE	SOIL TYPE	N : BLOWS/FT T : INCH/100 BLOWS P : TONS/SQ. FT. R : PERCENT RQD : RATIO	MOISTURE CONT. %	DRY DENSITY pounds/ft. 3	Atterberg Limits % Liquid Limit	Atterberg Limits % Plastic Limit	Atterberg Limits % Plasticity Index	MINUS No. 200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN %	DESCRIPTION OF STRATUM
0	▥	▨										LEAN CLAY - with sand, dark brown (CL)
	▥	▨	P=4.5+	13	107	36	13	23	84	7.8	3.9	
	▥	▨										- brown and gray (CL)
	▥	▨	P=4.5+									
	▥	▨										- with sand and some calcareous, light reddish brown (CL)
5	▥	▨	P=1.5	10	106	41	15	26	82	1.5	15.0	
	▥	▨										- with some calcaroeus, reddish brown (CL)
	▥	▨	P=1.0									
	▥	▨										- reddish brown (CL)
	▥	▨	P=0.5									
10		▨										
	▥	▨	P=0.5	22		45	14	31	87			
15		▨										
		▨										- reddish gray (CL)
	▥	▨	P=3.5	21	104	40	13	27	98	1.0	8.6	
20		▨										
	■	▨										- red (CL)
25												Boring terminated at 25.0'
30												
35												

▥ **Steel Tube Sample**

☒ **Split Spoon Sample**

■ **Disturbed Sample**

REMARKS:

TSI
Laboratories, Inc.

Log of Boring

PROJECT: Matagorda County JP Office
Magnolia Street & Center St.
Matagorda, TX 77457

CLIENT: Lynn Engineering

BORING NO.: B-2
LAB NO.: G-251175
DATE: 07/21/25
SURFACE ELEV.: N/A

DRILLING METHOD(S) : Dry Auger 0-25.0'

GROUNDWATER INFORMATION:
Groundwater was encountered at 13.5'

FIELD DATA				LABORATORY DATA								
DEPTH (FEET)	SAMPLE	SOIL TYPE	N : BLOWS/FT T : INCH/100 BLOWS P : TONS/SQ. FT. R : PERCENT RQD : RATIO	MOISTURE CONT. %	DRY DENSITY pounds/ft. 3	Atterberg Limits % Liquid Limit	Atterberg Limits % Plastic Limit	Atterberg Limits % Plasticity Index	MINUS No. 200 SIEVE (%)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN %	DESCRIPTION OF STRATUM
0	▥	▨	P=4.5									FAT CLAY - dark grayish brown (CH)
	▥	▨	P=3.5	21	101	50	17	33	88	1.4	15.0	- gray (CH)
5	▥	▨	P=3.0									- reddish gray (CH)
	▥	▨	P=2.0	18	108	51	17	34	62			GRAVELLY FAT CLAY - red (CH)
10	▥	▨	P=2.0	23	100	37	14	23	77	0.7	15.0	LEAN CLAY - with sand, reddish brown (CL)
15	▥	▨	P=4.5+									
20	▥	▨	P=3.0									- reddish brown (CL)
	▥	▨	P=3.5	20	106	38	16	22	90			
25												Boring terminated at 25.0'
30												
35												

▥	**Steel Tube Sample**
☒	**Split Spoon Sample**
▮	**Disturbed Sample**

REMARKS:

TSI
Laboratories, Inc.

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
▨	Low plasticity clay
▨	High plasticity clay
▦	Poorly graded clayey silty sand
▒	Clayey sand
Soil Samplers	
▥	Steel Tube Sample
☒	Split Spoon Sample
◨	Disturbed Sample

Consistency of Sands & Gravels	
Consistency	**Penetration Resistance (N)* Blows Per Foot**
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	Over 50

Consistency/Strength of Clays & Silty Clays		
Consistency	**Undrained Shear Strength, tsf**	**Pocket Penetrometer (p)**
Very Soft	Less than 0.125	0 – 0.5
Soft	0.125 – 0.25	0.5 – 1.0
Firm	0.25 – 0.50	1.0 – 1.75
Stiff	0.50 – 1.0	1.75 – 3.5
Very Stiff	1.0 – 2.0	3.5 – 4.5
Hard	Over 2.0	Over 4.5

*N=Number of Blows from 140 lb. hammer falling 30”to drive a 1-3/8” ld. split barrel sample (ASTM D-1586)

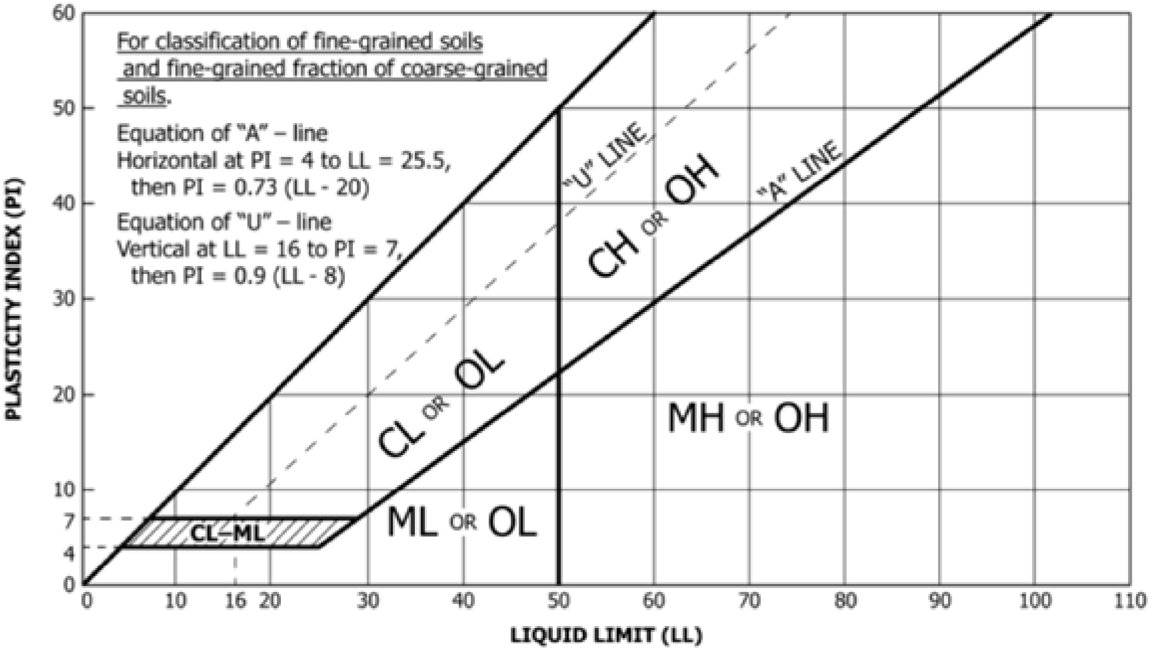
Soil Grain Analysis
US Standard Sieves

6” 3” ¾” #4 #10 #40 #200

Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		

152 76.2 19.1 4.76 2.0 0.420 0.074 0.002

Soil Grain Size in Millimeters
ASTM D-2488



FIELD AND LABORATORY TESTING PROCEDURES
(TEST PROCEDURES ARE PRESENTED FOR INFORMATIONAL PURPOSES)

FIELD TESTING

A. Boring Procedure Between Samples

The borehole is extended downward, between samples, by continuous flight, hollow or solid stem augers or by rotary drilling techniques using bentonite drilling fluid or water.

B. Penetration Test and Split-Barrel Sampling of Soils
ASTM D-1586

This sampling method consists of driving a 2-inch outside diameter split barrel sampler using a 140 pound hammer freely falling through a distance of 30 inches. The sampler is first seated 6 inches into the material to be sampled and then driven an additional 12 inches. The number of blows required to drive the sampler the final 12 inches is known as the Standard Penetration Resistance. Recovered samples are first classified as to color and texture by the driller. Later, in the laboratory, the driller's field classification is reviewed by the soils engineer who examines each sample.

C. Thin-Walled Tube Geotechnical Sampling
ASTM D-1587

This method consists of pushing thin walled steel tubes, usually 3 inches in diameter, into the soils to be sampled using hydraulic or other means. Cohesive soils are usually to be sampled in this manner and relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings
ASTM D-1452

This method consists of augering a hole and removing representative soil samples from the auger flight or bit at 5 foot depth intervals or with each change in substrata. Disturbed sampled are obtained and this method is, therefore, limited to situations where it is satisfactory to determine the approximate subsurface profile.

E. Diamond Core Drilling for Site Investigation
ASTM D-2113

This method consists of advancing a hole into hard strata by rotating a single or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings and cool the bit. Normally, a 2 inch outside diameter by 1-3/8 inch inside diameter (NX) coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and in the laboratory and the cores are stored in partitioned boxes. The core recovery is the length of the material recovered and is expressed as a percentage of the total distance penetrated.

F. Visual – Manual Soil Classification Procedure
ASTM D-2488

This procedure is a visual – manual soil classification methodology for the description of soil for engineering purposed when precise soils classification is not required.

LABORATORY TESTING

A. Atterberg Limits: Liquid Limit, Plastic Limit and Plasticity Index of Soils
ASTM D-4318, TEX 104-E, 105-E and 106-E

Atterberg Limits determine the soil's plasticity characteristics. The soil's Plasticity Index (PI) is representative of this characteristic and is the difference between the Liquid Limit (LL) and the Plastic Limit (PL). The LL is the moisture content at which the soil will flow as a heavy viscous fluid. The PL is the moisture content at which the soil begins to lose its plasticity. The test results are presented on the boring logs adjacent to the appropriate sampling information.

B. Particle Size Analysis of Soils
ASTM D-422 and TEX 110-E

Grain size analysis tests are performed to determine the particle size and distribution of the samples tested. The grain size distribution of the soils coarser than the Standard Number 200 sieve is determined by passing the sampled through a standard set of nested sieves.

C. Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D-2216 and TEX 103-E

The moisture content of soil is defined as the ratio, expressed as a percentage, of the weight of water in a given soil mass to the weight of solid particles. It is determined by measuring the wet and oven dry weights of a soil sample. The test results are presented on the boring logs.

D. Unconfined Compressive Strength of Cohesive Soil
ASTM D-2166

The unconfined compressive strength of soil is determined by placing a section of an undisturbed sample into a loading frame and applying an axial load until the sample fails in shear. The test results are presented on the boring logs adjacent to the appropriate sampling information.

E. California Bearing Ratio (CBR) of Lab Compacted Soils
ASTM D-1883

The CBR test is performed by compacting soil in a 6 inch diameter mold at the desired density, soaking the sample for four days under a surcharge load approximating the pavement weight and then testing the soils in punching shear. A 2 inch diameter piston is forced into the soil to determine the resistance to penetration. The CBR is the ratio of the actual load required to produce 0.1 inches of penetration to that producing the same penetration in a standard crushed stone.

F. Swell Test
ASTM D-4546

The swell test is performed by confining a 1 inch thick specimen in a 2-1/2 inch diameter stainless steel ring and loading the specimen to the approximate overburden pressure. The test specimen is then inundated with distilled water and allowed to swell for 48 hours. The volumetric swell is measured as a percentage of the total volume and is converted mathematically to linear swell.

G. Compaction Tests
ASTM D-698, D-1557, TEX 113-E or 114-E

The compaction test is performed by compacting soil in a steel mold at varying moisture contents. Layers are compacted using a hammer weight and number of blows per layer which vary with the different test procedures. ASTM D-698, D-1557, TEC 113-E and 114-E. The data is plotted and the maximum weight and optimum moisture content is determined.

H. Classification of Soils for Engineering Purposes
Unified Soil Classification System, D-2487

This standard describes a system for classifying mineral and organo-mineral soils for engineering purposes based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index and shall be used when precise classification is required.

RECOMMENDED SPECIFICATIONS FOR PLACEMENT OF SELECT FILL

1. General

The soils engineer shall be the owners representative to control the placement of compacted fill. The soils engineer shall approve the subgrade preparation, the fill materials, the method of placement and compaction, and shall give written approval of the completed fill.

2. Preparation of Existing Ground

All topsoil, plants and other organic material shall be removed. The exposed surface shall be scarified, moistened if necessary, and compacted in the manner specified for subsequent layers of fill.

3. Select Fill Material

Fill shall have a liquid limit of less than 35 and a Plasticity Index between 8 and 18. The fill shall contain no organic material or other perishable material, and no stones larger than 6 inches. Fill material shall be approved by the soils engineer.

4. Placing Select Fill

Fill materials shall be placed in horizontal layers not exceeding 8 inches thickness after compaction. Successive loads of material shall be dumped so as to secure even distribution, avoiding the formation of layers of lenses of dissimilar materials. The contractor shall route hill hauling equipment to distribute travel evenly over the fill area.

5. Compaction of Select Fill

a. Moisture Control: The moisture content of the fill material shall be distributed uniformly throughout each layer of the material. The allowable range of moisture content during compaction shall be within plus two (+2) and minus two (-2) percentage points of the optimum moisture content. The contractor may be directed to add necessary moisture to the material either in the borrow area or upon the fill surface or to dry the material, as directed by the soils engineer. The drying of cohesive soils between lifts to moisture contents less than 70% of optimum before the placement of subsequent lifts shall be avoided or the fill reworked at the proper moisture content.

b. Compaction: The material in each layer shall be compacted to obtain proper densities. Compaction by the hauling equipment alone will not be considered sufficient. Structural fills, including pavement subgrade, subbase, and base, shall be compacted to densities equivalent to the percentages of the Standard Proctor (ASTM D-698) or Modified Proctor (ASTM D-1557) maximum dry density listed in the table below. The Texas Department of Highways and Public Transportation Method TEX 113-E or TEX 114-E compaction test, which varies the compactive effort with soil type, may be substituted for the Standard or Modified Proctor methods and percentages listed in the table below.

	PERCENT COMPACTION	
Area	Fine Grained Soils ASTM D-698 (Standard) or TEX 114-E	Coarse Grained Soils ASTM D-1557 (Modified) or TEX 113-E
Within five (5) feet of building lines, under footings, floor slabs, slab-on-grade foundation and structures attached to the building (i.e. walls, patios, steps)	95	95+
More than five (5) feet beyond building lines, under walks, and fill area to be landscaped	90	90
Pavement subgrade and subbase, including lime treated soils	95	95+

Soils classified as coarse grained soils are those with more than 50%, by weight, retained on the No. 200 Standard Sieve.

6. Comparison Testing

Field density tests for the determination of the compaction of the fill shall be performed by TSI Laboratories, Inc. in accordance with recognized procedures for making such tests. A representative number of tests shall be made in each compacted lift at locations selected by the soils engineer or his/her representative. For general structural and paving fills, we suggest one test per 3,000 square feet per lift with a minimum of three tests per lift.

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL ENGINEERING REPORT

The following observations and suggestions are provided to help you better utilize your geotechnical engineering report and to reduce construction problems and delays related to the soil and groundwater conditions.

REPORT IS BASED UPON SPECIFIC SITE AND PROJECT

A geotechnical report is based on a subsurface exploration conducted on a specific site and planned using specific project information. The project information typically includes structure size and configuration, type of construction, and general location on the site. Limitations, such as existing buildings or utilities, specific foundation requirements for structures, budget limitations, and the level of risk assumed by the client may affect the scope of the exploration.

Since the report applies to a specific structure and site, the geotechnical report should not be used in the following circumstances unless the geotechnical engineer has reviewed the changes and concurs in the use of the report.

- When the nature of the proposed structure is changed, such as an office building instead of a warehouse or parking garage, or a refrigerated warehouse instead of one which is not refrigerated
- When the size, configuration, or floor elevations is changed
- When the location of the structure on the site is changed
- When there is a change of ownership

FINDINGS ARE PROFESSIONAL ESTIMATES

The actual subsurface conditions are determined only at the boring locations and only at the time the samples are taken. The information is extrapolated by the geotechnical engineer who then renders professional opinions regarding the characteristics of the subsurface materials, the behavior of the soils during construction, and appropriate foundation designs. No exploration, however complete, can be assured of sampling the entire range of soil conditions. The soils may vary between or beyond the borings and stratum transitions may be more gradual or more abrupt, and all types of oils and rock existing on the site may not be found in the borings. The geotechnical engineer is often retained during construction to evaluate variances and recommend solutions to problems encountered on the site.

SUBSURFACE CONDITIONS CAN CHANGE

Grading operations on or close to the site, floods, groundwater fluctuations, utility construction, and utility leaks are among the events that can change the subsurface conditions. The geotechnical engineer should e kept apprised of such events.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

A geotechnical report may have been made to evaluate foundation alternatives only, for preliminary site evaluation, or for other limited purposes. The exploration may also have been limited by the direction of the client, budget limitations, or the level of risk assumed by the client. Therefore, no one other than the original client should use the report for its intended purpose or other purposes without conferring with the geotechnical engineer.

GEOTECHNICAL REPORTS ARE SUBJECT TO MISINTERPRETATION

Geotechnical reports are based on the project information available at the time the report was made and the judgment and opinions of the geotechnical engineer. This specialized information is subject to misinterpretation by other design professionals, contractors and owners. The geotechnical engineer should be retained during the design process to interpret the recommendations and review the adequacy of the plans and specifications relative to geotechnical issues. The boring logs should no be separated from the geotechnical report, but, rather the entire report should be made available to the contractors and others needing this information.