Texas A&M RGV Brownsville - Lift Station

Geotechnical Engineering Report

Brownsville, Texas

October 1, 2025 | Terracon Project No. 88255143

Prepared for:

Port of Brownsville
1000 Foust Road
Brownsville, Texas 78521

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October 1, 2025

Port of Brownsville
1000 Foust Road
Brownsville, Texas 78521

Attn: Mr. Manuel Martinez
P: (956) 838 7029
E: mmartinez@portofbrownsville.com

Re: Geotechnical Engineering Report
Texas A&M RGV Brownsville - Lift Station
18505 TX-48
Brownsville, Texas
Terracon Project No. 88255143

Dear Mr. Martinez:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P88255143 dated September 10, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon
(Texas Firm Registration No. F-3272)

Samantha Leal
Staff Engineer

STATE OF TEXAS
ALFONSO A. SOTO
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LICENSED
PROFESSIONAL ENGINEER
10/01/2025

Alfonso A. Soto, P.E., BC.GE, F. ASCE
Senior Principal

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Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Report Summary

Topic [1]	Overview Statement [2]
Project Description	Texas A&M Brownsville - Lift Station
Geotechnical Characterization	The subsurface soils at this site generally consist of Lean Clay (CL). Groundwater was observed in the boring between depths of 6½ and 7½ feet below existing grade (beg) during drilling and after a 15-minute wait period.
Potential Vertical Rise (PVR)	The existing Potential Vertical Rise (PVR) of the soils within the proposed lift station area in present condition is about 1 inch. However, the PVR is significantly lower below the base of the proposed footing foundation, which is anticipated to be about 16 feet below existing grade.
Seismic Site Classification	The subsurface conditions within the site are consistent with the characteristics of Site Class E as defined in the International Building Code (IBC) Site Classification.
Foundations	A non-stiffed slab or mat foundation system would be appropriate to support the structural loads of the proposed structure.
Earthwork	Existing on-site soil may be used for general fill.
Below Grade Structures	A 6-to 8-foot diameter fiberglass wet well.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed Texas A&M RGV Brownsville - Lift Station to be located at 18505 TX-48 in Brownsville, Texas. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Excavation considerations
- Foundation design and construction
- Lateral earth pressure
- Groundwater control

The geotechnical engineering Scope of Services for this project included the advancement of a test boring, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring location are shown on the **Site Location** and **Exploration Plan**, respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring log in the **Exploration and Laboratory Results** section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	By Mr. David Perez with Perez Consulting Engineers on September 8, 2025.
Project Description	The project will include the design and construction of a new lift station facility and related equipment.

Item	Description
Proposed Structure	The lift station facility may consist of the following ▪ Concrete cover slab ▪ 6 to 8-foot diameter fiberglass wet well ▪ Suction pipe ▪ Pumps ▪ Bottom foundation concrete slab (approx. 16 feet below existing grade)
Construction Type	The structure may consist of a prefabricated fiberglass wet well with a concrete foundation slab and concrete cover.
Finished Floor Elevation (FFE)	Information was not provided.
Grading/Slopes	We anticipate that the minimum excavation depth is expected to be at least 16 feet below existing grade.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project site is located at 18505 TX-48 in Brownsville, Texas. Approx. GPS coordinates: Latitude: 25.972608° N Longitude: 97.366136° W See **Site Location**
Existing Improvements	Undeveloped land
Current Ground Cover	Native grass, bare soils
Existing Topography	Relatively flat and level

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of the site. Conditions observed at the exploration point are indicated on the log. The log can be found in the **Exploration Results** and the GeoModel can be found in the **Figures** attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at the boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Clay**	Lean Clay (CL); medium stiff to stiff

Groundwater Conditions

The boring was advanced using a dry augered drilling technique that allows short term groundwater observations to be made while drilling. Groundwater seepage was encountered at the time of our field exploration.

The boring was observed during and after completion of drilling for the presence and level of groundwater. The water levels observed are noted on the attached boring log and are summarized below.

Boring Number	Approximate depth to groundwater, feet [1]	
	While drilling	After a 15-minute wait period
B-1	7½	6½

1. Below ground surface

Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels.

Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. The borehole was backfilled with on-site soil cuttings and bentonite chips after completion of the groundwater level observations.

Geology

The Geologic Atlas of Texas, McAllen - Brownsville published by the University of Texas, has mapped the Alluvium Formation of the Phanerozoic eon, Cenozoic era, Quaternary period, Holocene (Recent) epoch in the vicinity of this site. Floodplain deposits, the lower course of Rio Grande, are divided into areas dominantly mud and areas dominantly silt and sand. All other areas are alluvium undivided, except for some areas where tidal flat areas are mapped. The soil is mostly composed of clay, silt, sand, gravel, and organic matter. The silt and sand are described as calcareous and dark gray to dark brown in color. The sand is mostly quartz and the gravel along Rio Grande include sedimentary rocks from the Cretaceous and Tertiary and a wide variety of igneous and sedimentary rocks from Trans-Pecos Texas, Mexico, and New Mexico including agate. The gravel in side streams of the Rio Grande is mostly Tertiary rocks and chert derived from Uvalde Gravel.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil properties observed at the site and as described on the exploration log and results, our professional opinion is for that a **Seismic Site Classification of E** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 30 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Boring	Sample Depth, feet	Soil Description	pH	Soluble Sulfate, mg/kg	Sulfides, mg/kg	Chloride, mg/kg	Electrical Resistivity, Ω-cm
B-1	6½ - 8	Lean Clay	9.3	3	nil	144	826

Results of soluble sulfate testing can be classified in accordance with ACI 318 – Building Code Requirements for Structural Concrete. Numerous sources are available to characterize corrosion potential to buried metals using the parameters above. ANSI/AWWA is commonly used for ductile iron, while threshold values for evaluating the effect on steel can be specific to the buried feature (e.g., piling, culverts, welded wire reinforcement, etc.) or agency for which the work is performed. Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction. Consultation with a NACE certified corrosion professional is recommended for buried metals on the site.

Mapping by the NRCS includes qualitative severity of corrosion to concrete and steel. Based on this source, the near-surface materials are rated "Negligible" for corrosion to concrete and "Very Corrosive" for corrosion of steel.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test boring, provided that the recommendations in this report are implemented in the design and construction phases of this project. The subsurface materials generally consisted of Lean Clay (CL).

The suitability and performance of a soil supported foundation for a structure depends on many factors including the magnitude of soil movement expected, the type of structure, the intended use of the structure, the construction methods available to stabilize the soils, and our understanding of the owner's expectations of the completed structure's performance.

Moderately expansive soils are present on this site. This report provides recommendations to help mitigate the effects of soil settlement, shrinkage, and expansion. However, even if these procedures are followed, some movement in the structure should be anticipated. Eliminating the risk of movement may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the **Exploration Results**), engineering analyses, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations.

Site Preparation

Construction areas should be stripped of all vegetation, topsoil, organic soils and other unsuitable material. Additional excavation as recommended in this report or as needed should be performed within the proposed construction area.

Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional earthmoving equipment. The bottom of excavations should be thoroughly cleaned of loose soils and disturbed materials prior to backfill placement and/or construction.

Fill Material Types

Engineered fill should consist of approved materials, free of organic material, debris and particles larger than about 2 inches. The maximum particle size criteria may be relaxed by the geotechnical engineer of record depending on construction techniques, material gradation, allowable lift thickness and observations during fill placement.

Material property requirements for on-site soil for use as general fill and structural fill are noted in the table below:

Property	General Fill	Structural Fill [1]
Composition	Free of deleterious material	Free of deleterious material
Maximum particle size	6 inches (or 2/3 of the lift thickness)	2 inches
Fines content	Not limited	Less than 85% Passing No. 200 sieve

Property	General Fill	Structural Fill [1]
Plasticity	Not limited	Plasticity Index (PI) between 7 and 20
GeoModel Layer Expected to be Suitable[1]	1	--

1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Soil Type [1, 2, 3, 4]	USCS Classification	Acceptable Parameters (for Structural Fill)
Low Plasticity Cohesive	CL and/or SC	Liquid Limit less than 40 Plasticity Index (PI) between 7 and 20 Less than 85% Passing No. 200 sieve
Granular	Clayey Gravel, Caliche, Crushed Limestone and Crushed Concrete	Less than 50% passing No. 200 sieve
Flowable Fill	---	Confined areas and backfill for existing utility trenches
Cement-Stabilized Backfill	---	Used for backfilling of utility trenches in accordance with local standards or TxDOT Item 400 Excavation and Backfill for Structures

Soil Type [1, 2, 3, 4]	USCS Classification	Acceptable Parameters (for Structural Fill)

1. Structural and general fill should consist of approved materials free of organic matter and debris. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site. Additional geotechnical consultation should be provided prior to the use of uniformly graded gravel on the site.
2. Crushed limestone and crushed concrete material should meet the requirements of 2024 TxDOT Item 247, Type A, or D, Grade 1-2 or 3. The Structural Fill materials should be free of organic material and debris and should not contain stones larger than 2 inches in the maximum dimension. The clayey gravel materials should meet the gradation requirements of Item 247, Type B, Grade 1-2 or 3 and/or Type E (Caliche) Grade 4 as specified in the 2024 TxDOT Standard Specifications Manual and a Plasticity Index between 7 and 20.
3. Flowable fill should have a 28-day strength between 80 and 200 psi and meet the requirements for 2024 TXDOT Item 401. Although usually more costly, flowable fill does not require placement in lifts or mechanical compaction.
4. Cement-Stabilized Backfill should consist of non-plastic sand or caliche as aggregate with a minimum of 2 sacks of Type I Portland cement per cubic yard based on the dry weight of the aggregate or as indicated by local standards. No mixing will be allowed on the project site surface.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	8 inches in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used	
Minimum Compaction Requirements [1,2,3]	95% of MDD below foundations and within 1 foot of finished pavement subgrade 95% of MDD above foundations, below concrete slabs, and more than 1 foot below finished pavement subgrade	
Water Content Range [1]	Low plasticity cohesive: -2% to +2% of optimum High plasticity cohesive: 0 to +4% of optimum Granular: -2% to +2% of optimum	

Item	Structural Fill	General Fill

1. Maximum Dry Density (MDD) and optimum water content as determined by the Standard Proctor test (ASTM D 698).
2. High plasticity cohesive fill should not be compacted to more than 100% of Standard Proctor maximum dry density.
3. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254). The caliche, crushed limestone and crushed concrete should be compacted to at least 95% of the Modified Proctor Test (ASTM D 1557). Materials not amenable to density testing should be placed and compacted to a stable condition observed by the Geotechnical Engineer or representative.

Wet Weather/Soft Subgrade Considerations

Construction operations may encounter difficulties due to the wet or soft surface soils becoming a general hindrance to equipment due to rutting and pumping of the soil surface, especially during and soon after periods of wet weather.

If the subgrade cannot be adequately compacted to minimum densities as described above, one of the following measures will be required:

- Removal and replacement with structural fill,
- Chemical treatment of the soil to dry and increase the stability of the subgrade,
- Drying by natural means if the schedule allows.

In our experience with similar soils in this area, chemical treatment is an efficient and effective method to increase the supporting value of wet and weak subgrade. Terracon should be contacted for additional recommendations if chemical treatment of the soils is needed.

Prior to placing any fill, all surface vegetation, topsoil, possible fill material and any otherwise unsuitable materials should be removed from the construction areas. Wet or dry material should either be removed, or moisture conditioned and recompacted.

Groundwater/Dewatering Control

Groundwater seepage and water flow may be anticipated during construction excavation; an effective temporary or permanent groundwater/dewatering control system may be needed at this site.

The design, operation, and maintenance of dewatering systems and groundwater control should be the responsibility of the contractor. This is appropriate since water control affects construction operations, e.g. excavation and scheduling.

We anticipate the system would likely consist of one the following dewatering control methods:

- Sump Pumps: It is considered the most common dewatering method and is typically used in shallow excavations with sandy or gravelly soils.
- Deep Well Point: This procedure uses submersible pumps inserted in drilled boreholes around the excavation.
- Eductor Wells: It is like the well point procedure using high pressure water instead of a vacuum. This method is applicable for low permeability clay soil and can be used for depths up to 130 feet.
- Well Point: The well point procedure consists of a series of wells with a riser pipe, connected to a header pipe and vacuum pump. It works better for shallow depths up to 20 feet.

Discharge should be arranged to facilitate sampling by the engineer.

Underground Utility Bedding

The subgrade and bedding for underground utilities should conform to Item 400 Excavation and Backfill for Structures" of the 2024 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges. The soil observed in the boring at the estimated utility bedding depths generally consisted of medium stiff to very stiff soils.

The underground pipes placed in a dry and/or wet trench bottom should be placed in accordance with guidelines for ordinary bedding details as outlined in Item 400 "Excavation and Backfill for Structures" of the 2024 TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges. The bedding materials utilized should conform 2024 TxDOT Specifications Item No. 247 Type A, B, or C. Since the groundwater level is expected to vary across the proposed underground alignment, the decision on bedding to be utilized may be made in the field based on actual conditions at the time of construction and the response of the soil and water to open trenching.

The excavations should be monitored to detect any variation in soil conditions from that found in the boring. Any changes noted in the soil stratigraphy should be brought to the attention of Terracon so that the conditions may be assessed and changes to the planned bedding requirements made, as necessary.

Utility Trench Backfill

The type of fill placed above the utility bedding will depend on whether the surface above the line will be covered with pavement or will consist of unpaved ground. If the surface is to be unpaved ground, then the backfill may consist of the excavated, in-situ soils. The in-situ soils used as backfill should be placed in thin lifts, moisture conditioned to within 2 percent of the optimum moisture content and compacted to at least 90 percent of the maximum dry density as determined by the Standard Effort (ASTM D-698). Within pavement areas, the backfill should consist of cement stabilized sand to within 12 inches of the top of the subgrade, compacted to at least 95 percent of the Standard Effort (ASTM D-698) maximum dry density. The upper 12 inches may consist of clean soils compacted to 95 percent of the Standard Effort (ASTM D-698) maximum dry density within 2 percent of the optimum moisture content.

Prior to any filling operations, samples of the proposed borrow materials should be obtained for laboratory moisture-density testing. The tests will provide a basis for evaluation of fill compaction by in-place density testing. A qualified soil technician should perform sufficient in-place density tests during the filling operations to verify that proper levels of compaction are being attained.

Grading and Drainage

Positive drainage should be provided during construction and maintained throughout the life of the development. Infiltration of water into utility trenches or foundation excavations should be prevented during construction.

Earthwork Construction Considerations

Excavations for the proposed lift station are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of slabs. Construction traffic over the completed subgrade should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrade or in excavations. Water collecting over, or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to concrete slab construction.

The groundwater table could affect over excavation efforts, especially for over excavation and replacement of lower strength soils. A temporary dewatering system may be necessary to achieve the recommended depth of over excavation depending on groundwater conditions at the time of construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include reviewing available final grading information or consider potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, and mitigation of areas delineated by the proof-roll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill. In the event unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Lift Station

Non-Stiffened Slab or Mat Foundation Design Parameters

The project involves the design and construction of a proposed lift station. Based on information provided, it is expected that the lift station structure will be bearing approximately 16 feet below top of concrete slab. We understand that the lift station will be constructed in the vicinity of Boring B-1 and may consist of a 6-to-8-foot diameter fiberglass wet well structure. A concrete slab will be constructed on the top of the wet well.

A non-stiffened slab or mat foundation may be used to support the proposed lift station. The mat should be analyzed using a soil-structure interaction program to identify areas of high contact stresses, excessive movements and large moments. If a Winkler-type subgrade modulus model is utilized to model the mat response to load, a subgrade modulus (k) of 90 pounds per cubic inch (pci) can be utilized. Allowable bearing pressure should not exceed 1,500 psf. The indicated bearing pressure includes a factor of safety against a bearing capacity failure of at least 3. Contact stresses should be distributed, so that yield does not occur.

Post construction settlements for a mat foundation designed for the indicated contact pressures should be less than 1 inch. Differential settlements between the center and edge of the mat foundation should be on the order of ½ to ¾ of an inch assuming proper construction. If the degree of movement indicated in this report is not tolerable, the mat foundation may be placed deeper and/or may be thickened to further increase its stiffness.

Buoyant Uplift Pressures

The pump station structure should be designed to withstand buoyant uplift forces. Groundwater was observed at the time of our field investigation. If water infiltrates and accumulates in the backfill around the structure, buoyancy forces can develop to whatever height the water rises. We recommend that the pump station structure be designed to resist buoyant forces equivalent to subsurface water levels at the ground surface unless positive measures are taken to prevent water infiltration and accumulation in the backfill around the structure.

Uplift forces on below-grade structures such as manholes will be generated by a difference in water level in the soil adjacent to the structure and inside the structure. If the backfill around any buried structure is a sand or silt material, the backfill will approach saturation during periods of heavy rainfall and the effective static water level will be at the surface. The uplift pressures will be resisted by adhesion or skin friction of the soil to the wall and by the dead weight of the structure. An allowable skin friction for on-site native clayey fill compacted to a minimum of 95 percent of the Standard Effort ASTM D698 maximum dry density may be 300 pounds per square foot (psf), this value includes a factor of safety of 2. The upper 4 feet of skin friction should be neglected for the backfill material due to potential for soil shrinkage away from the structure. If sand backfill, compacted to at least 70 percent of the maximum relative density (ASTM D4253 and ASTM D4254), may be considered to have an allowable skin friction of zero at the surface varying linearly to 35 psf at 5 feet, 70 psf at 10 feet and 105 psf at 15 feet below grade.

An alternate design method would be to place a heel extending out from the foundation slab into the backfill and rely on the weight of the soil above the heel on a 4-vertical to 1-horizontal (4V:1H) slope to resist the uplift forces. The unit weight of soil above and below the water table for a properly compacted backfill will be 120 and 60 pounds per cubic feet (pcf), respectively. The preparation of the upper three feet of soil immediately above the heel is critical to reduce the possibility of an upward bearing failure. The entire thickness of fill should be compacted to the above recommended values.

If underground structures are installed by excavating from the inside and allowing the structure to sink under its own weight, the soil contact may be very low immediately after construction due to the annulus created during construction. In this case, the uplift pressure must be resisted by structural dead weight or by restoring the contact between the soil and the structure. If the annulus is open, grouting would be one means to restore skin frictional resistance. If the annulus is properly grouted, a nominal allowable skin friction of 150 psf may be used to compute uplift resistance.

Foundation Construction Considerations

As noted in **Earthwork**, the foundation excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the foundation excavations should be removed/reconditioned before foundation concrete is placed.

Excavation should be accomplished with a smooth-mouthed bucket. If a toothed bucket is used, excavation with this bucket should be stopped 6 inches above the final bearing surface and the excavation completed with a smooth-mouthed bucket or by hand labor.

If the bottom foundations are over-excavated and formed, the backfill around the foundation sides should be achieved with compacted structural fill, lean concrete, compacted cement stabilized sand (two sacks cement to one cubic yard of sand) or flowable fill. Compaction of structural fill should be performed as recommended in this report.

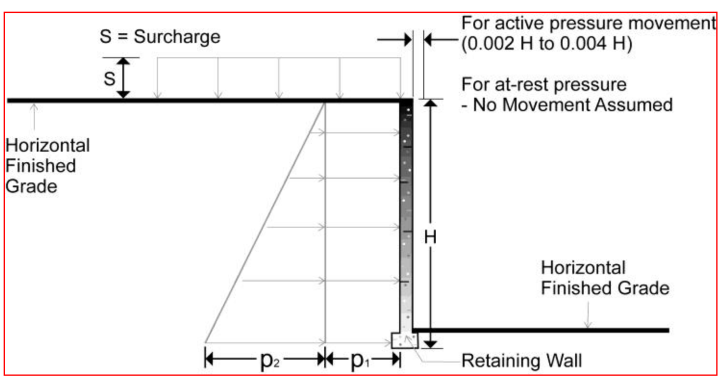
The bearing surface should be excavated with a slight slope to create an internal sump for runoff water collection and removal. If surface runoff water in excess of 2 inches accumulates at the bottom of the excavation, it should be pumped out prior to concrete placement. Under no circumstances should water be allowed to adversely affect the quality of the bearing surface. The backfill above the foundation may be the excavated on-site soils or structural fill soils. Backfill soils should be compacted to at least 95 percent of the maximum dry density as determined by the standard moisture/density relationship test (ASTM D 698). Moisture contents for on-site soils and imported structural fill soils should be within 2 percentage points of the optimum moisture content. The backfill should be placed in thin, loose lifts of about 8 inches, with compacted thickness not to exceed 6 inches.

If unsuitable bearing soils are observed at the base of the planned foundation excavation, the excavation should be extended deeper to suitable soils, and the bottom foundation could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The over-excavation should be backfilled up to the foundation base elevation, with structural fill placed, as recommended in this report.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3] p_1 (psf)	Equivalent Fluid Pressures (psf) [2,4]	
			Unsaturated	Submerged
Active (Ka)	Granular - 0.31 Structural Fill - 0.41 On-Site Soil - 0.49	(0.31)S (0.41)S (0.49)S	(40)H (50)H (60)H	(80)H (85)H (90)H
At-Rest (Ko)	Granular - 0.47 Structural Fill - 0.58 On-Site Soil - 0.66	(0.47)S (0.58)S (0.66)S	(60)H (70)H (80)H	(90)H (95)H (100)H
Passive (Kp)	Granular - 3.25 Structural Fill - 2.46 On-Site Soil - 2.04	--- --- ---	(425)H (295)H (245)H	(280)H (205)H (180)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, walls must move horizontally to mobilize resistance. Expansive soils should not be used as backfill behind the wall.
2. Soil parameters: <u>Structural Fill</u> (120 pcf with 25° Ø), <u>Granular Backfill</u> (130 pcf with 32° Ø) and <u>On-site soil</u> (120 pcf with 20° Ø).
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

To control hydrostatic pressure behind the wall we recommend that a drain be installed at the foundation wall with a collection pipe leading to a reliable discharge. If this is not possible, then combined hydrostatic and lateral earth pressures should be calculated for lean clay backfill using an equivalent fluid weighing 90 and 100 pcf for active and at-rest conditions, respectively. For granular backfill, an equivalent fluid weighing 85 and 90 pcf should be used for active and at-rest, respectively. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided. A 2-foot compacted cohesive seal should be placed at the top of backfill to reduce the amount of infiltration of surface water.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

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

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

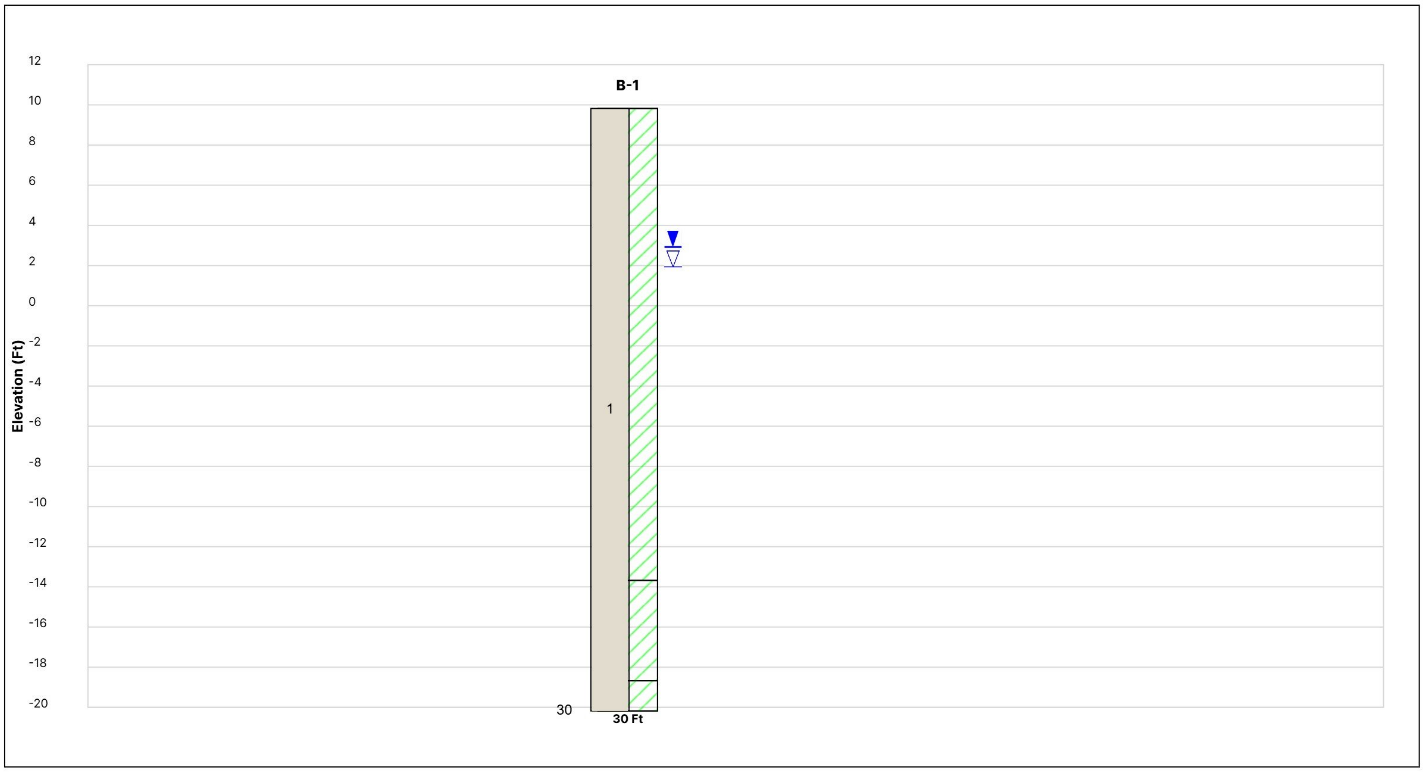
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

Terracon
1506 Mid Cities Dr Pharr , TX
78577-2128

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions

#	Layer Name	General Description
1	**Clay**	Lean Clay (CL); medium stiff to stiff

Legend
Lean Clay

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

First Water Observation

Second Water Observation

Third Water Observation

Notes:

Layering shown on this figure has been developed by the geo-technical engineer for purposes of modeling the subsurface conditions as required for the subsequent geo-technical engineering for this project.
Numbers adjacent to soil column indicate depth below groundsurface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
1	30	Proposed Lift Station Area

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ±10 feet) and referencing existing site features. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the boring with a truck-mounted, drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Five samples were obtained in the upper 10 feet of the boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring log at the test depths. For safety purposes, the boring was backfilled with auger cuttings after the groundwater observations were completed.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring log. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring log as part of the drilling operations. The field log included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring log was prepared from the field log. The final boring log represents the Geotechnical Engineer's interpretation of the field log and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Atterberg Limits
- Grain Size Analysis
- Corrosivity

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Site Location Plan

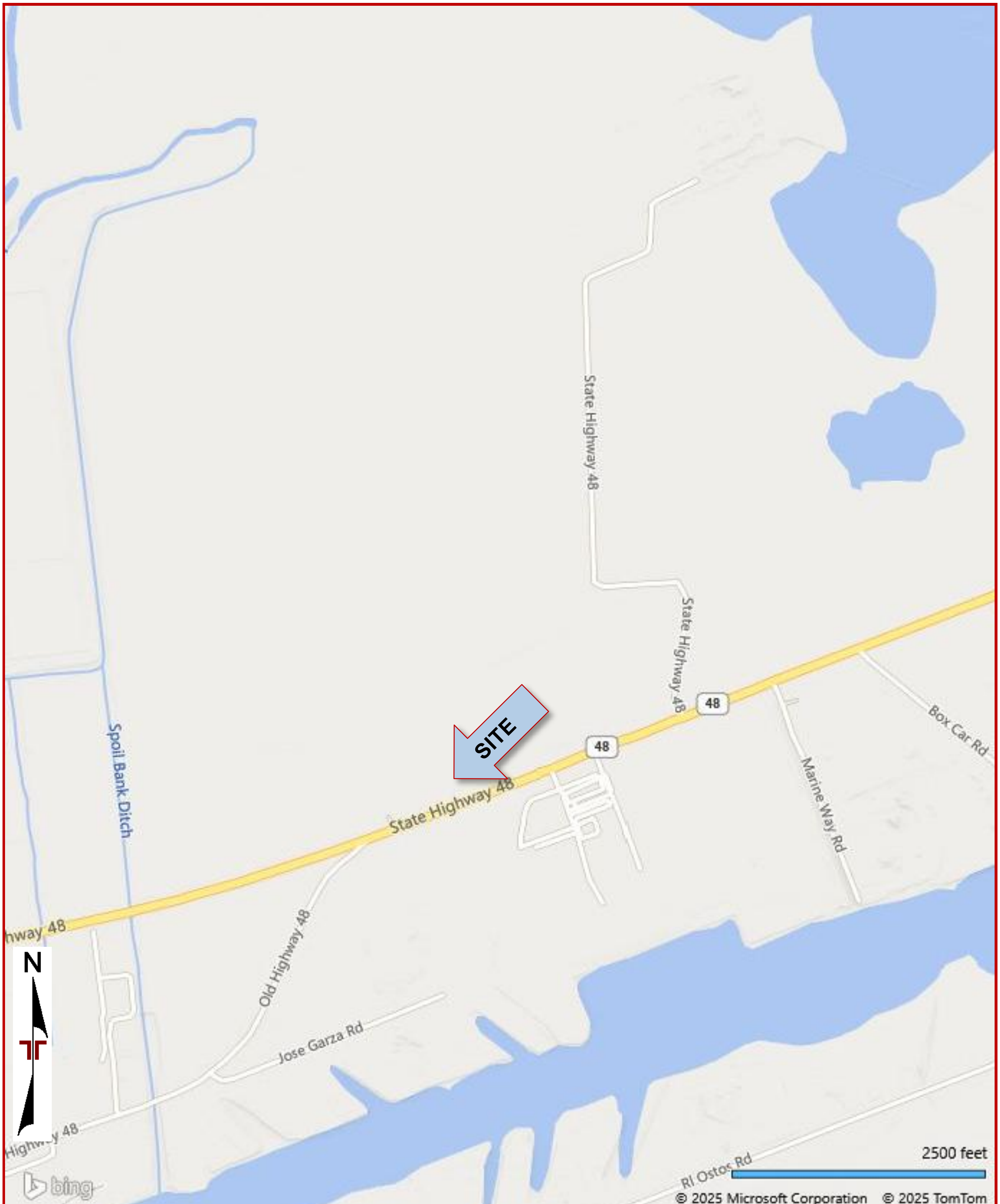


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

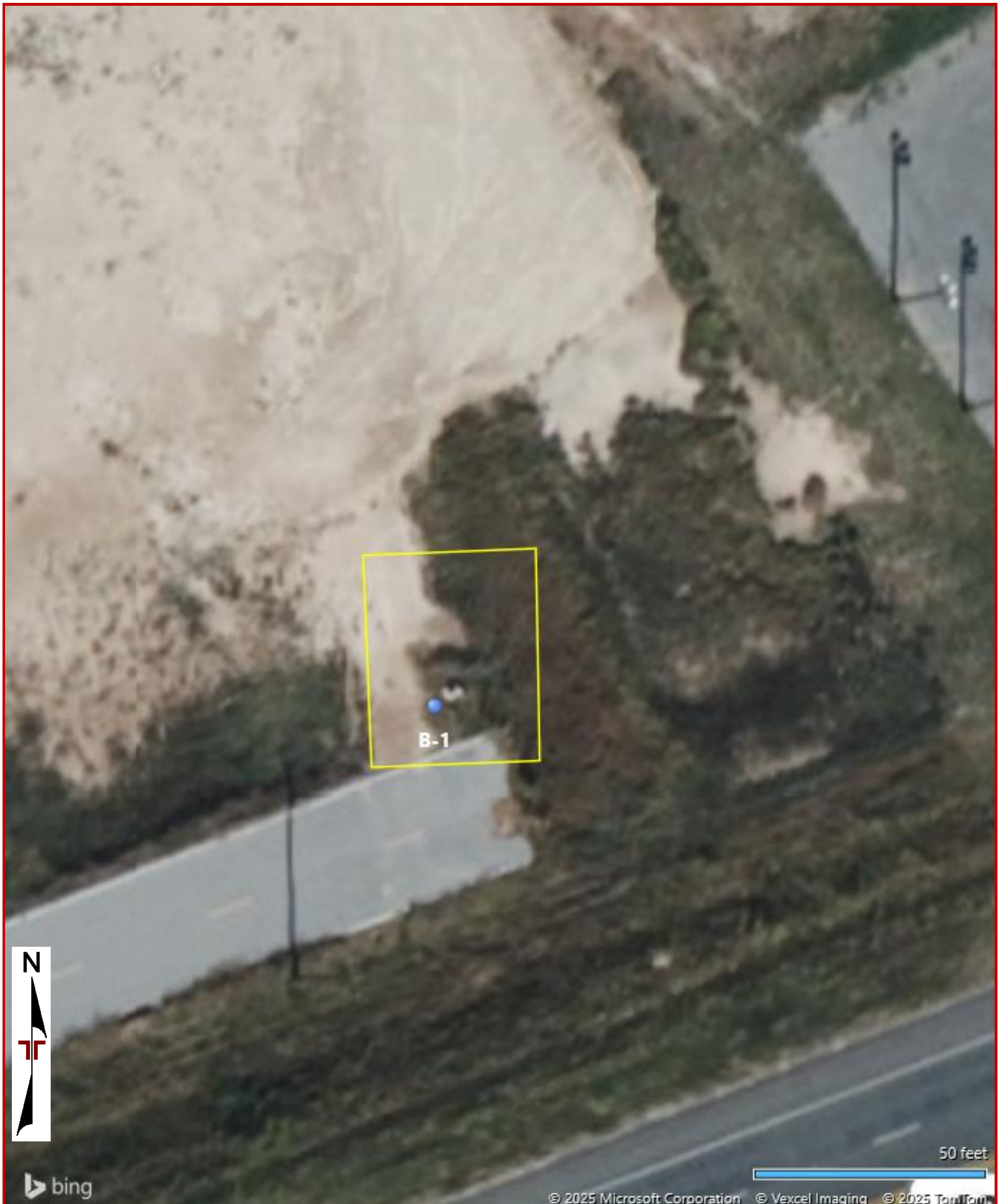


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration and Laboratory Results

Contents:

Texas A&M RGV Brownsville - Lift Station
18505 TX-48, Brownsville, TX,USA
Terracon Project No. 88255143

Latitude: 25.9726° Longitude: -97.3661°

Boring No. B-1

1506 Mid Cities Dr
Pharr, TX 78577-2128

Surface Elevation:
10(Ft) +/-

Model Layer	Graphic Log	Lithology Depth (Ft.)	Material Description	Depth (Ft.)	Sample Type	Water Level Observations	Field Test Results	Hand Penetrometer (tsf)	Water Content (%)	Percent Fines	Atterberg Limits LL	PL	PI
1			**LEAN CLAY (CL)**, brown, medium stiff				6-4-4 N = 8		12.8		36	18	18
								1.0	30.9	96.7			
				5.0			4-3-4 N = 7		25.1		43	17	26
							3-3-5 N = 8		24.5				
							4-4-3 N = 7		29.6		31	18	13
				10.0									
							5-4-4 N = 8		31.3	97.1			
				15.0									
							3-3-3 N = 6		28.7		30	21	9
				20.0									
		23.5	- stiff at 23½ feet				3-4-5 N = 9		27.0	93.4			
				25.0									
		28.5	- Silt (ML) at 28½ feet				3-2-3 N = 5		27.6		29	24	5
			Boring Terminated at 30 Ft										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes
Elevation Reference: Based on Google Earth imagery.

Water Level Observations
▽ 7.5 Ft. While Drilling
▼ 6.5 Ft. After 15 minutes

Advancement Method
0-10 Ft. Solid Stem/Flight Auger
10-30 Ft. Mud/Wash Rotary

Abandonment Method
Boring backfilled with soil cuttings and bentonite chips upon completion.

Drill Rig
Subcontractor - CME-55

Hammer Type
Automatic

Driller
SWD

Logged By
JG

Boring Started
09/17/2025

Boring Completed
09/17/2025

CHEMICAL LABORATORY TEST REPORT

Project Number: 88255143
Service Date: 09/23/25
Report Date: 09/28/25

Terracon
10400 State Highway 191
Midland, Texas 79707
432-684-9600

Client

Port of Brownsville
1000 Foust Rd
Brownsville, TX 78521-1000

Project

Texas A&M RGV Brownsville - Lift Station
18505 TX-48
Brownsville, TX

Sample Location	B-1
Sample Depth (ft.)	6.5-8
pH Analysis, ASTM G51-18	9.3
Water Soluble Sulfate (SO4), ASTM C1580 (mg/kg)	3
Sulfides, AWWA 4500-S D, (mg/kg)	nil
Chlorides, ASTM D512, (mg/kg)	144
RedOx, ASTM D1498, (mV)	+378
Total Salts, ASTM D1125-14, (mg/kg)	1,770
Resistivity, ASTM G57, (ohm-cm)	826

Analyzed By: Ibtissem Salem

Ibtissem Salem
Laboratory Coordinator

Supporting Information

Contents:

General Notes

Sampling	Water Level	Field Tests
Auger Cuttings; Modified California Ring Sampler; Rock Core; Dynamic Cone Penetrometer; Modified Dames & Moore Ring Sampler; Dual Sampler SPT; Grab Sample; GeoProbe Macro Core or Large Bore; No Recovery; Ring Sampler; Shelby Tube; Standard Penetration Test; Split Spoon; Texas Cone Penetrometer; Vane Shear	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N — Standard Penetration Test Resistance (Blows/Ft.) (HP) — Hand Penetrometer (T) — Torvane (DCP) — Dynamic Cone Penetrometer UC — Unconfined Compressive Strength (PID) — Photo-Ionization Detector (OVA) — Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**Consistency of Fine-Grained Soils** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (tsf)**	**Standard Penetration or N-Value (Blows/Ft.)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	5 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	9 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	16 - 30
		Hard	> 4.00	> 30

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	**Group Name** [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

A Based on the material passing the 3-inch (75-mm) sieve.
B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
E $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
F If soil contains ≥ 15% sand, add "with sand" to group name.
G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
H If fines are organic, add "with organic fines" to group name.
I If soil contains ≥ 15% gravel, add "with gravel" to group name.
J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
L If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
M If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
N PI ≥ 4 and plots on or above "A" line.
O PI < 4 or plots below "A" line.
P PI plots on or above "A" line.
Q PI plots below "A" line.