BROWNSVILLE
PUBLIC UTILITIES BOARD

Date: November 14, 2023
To: All Vendors
Subject: Addendum #2

REFERENCE: **B012-24 Town Resaca Watershed Project**

This Addendum forms part of the contract and clarifies, corrects or modifies original bid document.

See attached for questions and answers from Pre-Bid meeting, plus the Geotechnical Engineering Report.

The signature of the company agent, for the acknowledgement of this addendum, shall be required. **Complete information below and return via e-mail to: dsolitaire@brownsville-pub.com.**

I hereby acknowledge receipt of this addendum.

Company: ____

Agent Name: ____

Agent Signature: ____

Address: ____

City: ________________ **State:**________________ **Zip:**________

Phone Number: ______________ **E-mail address:**____________________

If you have any further questions about the Bid, call 956-983-6366.

BY: *Diane Solitaire*
Purchasing

halff
1075 Paredes Line Roa
Brownsville, TX 7852
Phone (956) 303-7100
TBPELS Firm No. 312

Project Addendum No. 2

Project:	**Brownsville PUB – Town Resaca Watershed Project (RESTORE)** **BPUB Bid No. B012-24**	**Addendum Date:**	**November 14, 2023**
From:	**John W. Clint, PE**	**Project No.:**	**42947.001**

ADDENDUM No. 2

Responses to Pre-Bid Meeting Questions

1. Can the Geotech report be made available?

   The Geotech report is available for download from the BPUB purchasing site however, please note the General Conditions in the Contract Documents, Article 4, Section 4.2.1.

2. Regarding the section of bulkhead it is noted that posts should be set where there are deflection points. Will the engineer provide where the posts should be set or will it be the responsibility of the contractor? Also, will the engineer provide more detail on the length of the sheet pile and rope lengths for the posts?

   The contractor will be responsible for the length of tie-back cabling and spacing of posts following the maximum allowed in the details and the manufacturer installation requirements.

3. Can the bypass flow requirements, in CFS, be provided for the weirs?

   Bypass flow requirements: 2 cfs and minimum 12” PVC to account for plugging for each location

4. Will BPUB be responsible for all of the utility conflicts in general?

   All utility conflicts need to be coordinated with BPUB

5. When is the deadline for submitting questions?

   The deadline for submitting questions is Thursday November 16, 2023 at 2 pm.

Revisions to Contract Documents

6. Article 3, Section 3.1 (pg. 49) of the Construction Agreement shall be revised to read “The Work shall be Substantially Completed in accordance with paragraph 14.8 of the General

Conditions within 270 consecutive Calendar Days after the date when the Contract Time commences to run as provided in paragraph 2.3 of the General Conditions, and finally completed and ready for final payment in accordance with paragraph 14.13 of the General Conditions within thirty (30) consecutive Calendar Days after the date of Substantial Completion as established in accordance with paragraph 14.8 of the General Conditions.

Town Resaca Improvements

Geotechnical Engineering Report

December 21, 2022 | Terracon Project No. 88225178

Prepared for:

Brownsville Public Utilities Board
1425 Robinhood Drive
Brownsville, TX 78521

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December 21, 2022

Brownsville Public Utilities Board
1425 Robinhood Drive
Brownsville, TX 78521

Attn: Ricardo Pineda, EIT
P: (956) 983 6227
E: rpineda@brownsville-pub.com

Re: Geotechnical Engineering Report
Town Resaca Improvements
Resaca Boulevard
Brownsville, Texas
Terracon Project No. 88225178

Dear Mr. Pineda:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P88225178 dated November 7, 2022. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork 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)

ALFONSO A. SOTO
94153

12/21/22

Martin Reyes
Group Manager

Alfonso A. Soto, P.E., D.GE
Senior Principal

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Figures

Attachments

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	Town Resaca Improvements
Geotechnical Characterization	Lean Clay (CL) and Silty Sand (SM) Groundwater was observed in the borings between depths of 2 and 10 feet below existing grade (beg) during drilling and after a 15-minute wait period.
Shallow Foundations	Shallow foundations are recommended for wall support Allowable bearing pressure = 1,500 psf Expected settlements: < 1-inch total, < ½-inch differential
Below-Grade Structures	Cantilevered or gravity wall design can be designed using the resistance values in the Shallow Foundation section of the report. Earth pressures acting are provided in the Lateral Earth Pressure section. Overexcavation of soft soils is expected below wall areas.
Earthwork	Existing on-site soils may be used for general fill
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 Town Resaca Improvements project located within the vicinity of Resaca Boulevard and W. 5th Street in Brownsville, Texas. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Excavation considerations
- Lateral earth pressures
- Foundation design and construction

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

Drawings showing the site and boring locations 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 logs 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 Ricardo Pineda with BPUB on October 31, 2022.
Project Description	Town Resaca Improvements
Proposed Improvements	The project will consist of bank improvements to minimize erosion, maximize stormwater infiltration and restoring habitat. Infrastructure improvements include replacing two (2) weir structures, replacing gates valves and stormwater interceptors.

Item	Description
Construction Type	We anticipate that the improvements will likely be supported by a shallow foundation system and/or stabilized bank subgrade.
Grading/Slopes	Bank slope will be adjusted to match existing slope conditions.

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 is located on Resaca Boulevard in Brownsville, Texas. ▪ Latitude/Longitude: 25.918169° N 97.507796° W, and ▪ Latitude/Longitude: 25.917238° N 97.500603° W See **Site Location**
Existing Improvements	Existing town resaca
Current Ground Cover	Native grass and bare soils
Existing Topography	Varies

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 each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration and Laboratory 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 each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Clay**	Lean Clay (CL); stiff to soft
2	**Sand**	Silty Sand (SM); very loose to loose

Groundwater Conditions

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

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

Boring Number	Approximate Depth to Groundwater, feet [1]	
	While Drilling	After a 15-Minute Wait Period
B-1	6	5
B-2	10	6
B-3	4	2
B-4	--	--
H-1	--	--
H-2	--	--
H-3	--	--

1. Below ground surface

The sand strata are considered volumetrically stable and due to their granular nature may transmit water easily during high sea level and rainfall periods. Groundwater conditions may be different at the time of construction. Groundwater conditions may change because of seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project. The boreholes were backfilled with on-site soil cuttings after completion of the groundwater level observations.

Geology

The Geologic Atlas of Texas (1976), McAllen - Brownsville sheet has mapped the Alluvium Formation of the Holocene (Recent) Period of the Quaternary age at or near this site. Floodplain deposits, 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 soils are 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 Class 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 logs and results, our professional opinion is for that a **Seismic Site Class of E** be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 20 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.

Geotechnical Overview

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the test borings, 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 and silty sand. Groundwater was encountered within the maximum depths of exploration during or at the completion of drilling.

Based on the conditions encountered and estimated load-settlement relationships, the proposed structures can be supported on a conventional shallow foundations system. The **Shallow Foundations** section addresses support of the wall directly bearing on native soils or engineered fill.

The foundations being considered to provide support for the planned structures must satisfy two independent engineering criteria with respect to the subsurface conditions encountered at this site. One criterion is the foundation system must be designed with an appropriate factor of safety to reduce the possibility of a bearing capacity failure of the soils underlying the foundation. The other criterion is movement of the foundation system due to compression (consolidation or shrinkage) or expansion (swell) of the underlying soils must be within tolerable limits for the structures.

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.

Loose and soft compressible 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 structures 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.

Site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

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

Weak Soils

Based on the borings performed at this site soils with consistency from soft to stiff and relative density from very loose to loose were encountered. Damage due to disturbance of weak soils should be controlled as much as possible, followed by installation of geogrid reinforcement or alternative stabilization options.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and backfill 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.

We have provided the following subgrade preparation option that is intended to establish a working platform and allow proper construction of the subbase or embankment areas.

- Dewater the affected areas, as needed.
- Construction activities will be initiated by stripping vegetation and other unsuitable materials. Stripped materials consisting of vegetation and organic materials should be wasted off site.
- If final grade requires fill, install Mirafi 160N nonwoven geotextile fabric (or equivalent) on the exposed native soils and geogrid as soil reinforcement and every 2 feet vertically, extend at least 5 feet horizontally beyond the limits of the wall area (if applicable) where fill needs to be placed. Grid should be covered with a minimum of 18 inches of granular base material before equipment can be operated over it. Geogrid may stop at about 12 inches below Final Pad Elevation (FPE). Placement and compaction equipment and methods above the geogrid should be controlled as needed to avoid disturbance of the underlying subgrade soil. Geogrid Tensar InterAx (or equivalent) may be used as structural soil reinforcement at this project.
- Place granular base material to achieve the final grade elevation and to seal the voids, as necessary. The granular base material should be placed in 8 inches loose lifts not exceeding 6 inches compacted lifts to at least 95 percent of the Maximum Dry Density (MDD) as evaluated by ASTM D 698 and moisture conditioned within 2 percentage points of the optimum moisture content.

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
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
Plasticity	Not limited	Plasticity Index (PI) between 7 and 20
GeoModel Layer Expected to be Suitable[1]	1 and 2	1 (lean clay)

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, if applicable.

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	SC, GC, Caliche, Crushed Limestone and Crushed Concrete	Less than 50% passing No. 200 sieve

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

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 use of uniformly graded gravel on the site.
2. Crushed limestone and crushed concrete material should meet the requirements of 2014 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 and caliche materials should meet the gradation requirements of Item 247, Type B, Grade 1-2 or 3 as specified in the 2014 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 2014 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 a 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 street 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	Same as structural fill

Item	Structural Fill	General Fill
Minimum Compaction Requirements [1,2,3]	95% of MDD below foundations 95% of MDD above foundations and more than 1 foot below finished pad subgrade	92% of MDD
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	As required to achieve minimum compaction requirements

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 Standard Proctor test (ASTM D 698). 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 select 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 Considerations

As mentioned previously, groundwater was observed during and upon completion of drilling activities. We anticipate groundwater seepage and existing water flow during construction excavation, which should be controlled at the time of construction and during the life of the wall structure. An effective and/or permanent groundwater/dewatering control system will be needed at this site. A drainage system should be required to collect/remove water. Dewatering is critical to prevent loss of support at the base of the excavation that could result in failure in the retention system.

If the proposed excavation is to be done with conventional equipment and extends into the underlying water-bearing soils, temporary dewatering will be necessary. Prior to design and installation of the dewatering system, we recommend that piezometers be installed and monitored to verify the groundwater levels. It is recommended that the groundwater level should be lowered at least 2 feet below the base of the planned excavation prior to digging the excavation.

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 a vacuum well point or jet eductor system. Well points should be installed with suitable screen and filters so that pumping of fines does not occur. Discharge should be arranged to facilitate sampling by the engineer.

Earthwork Construction Considerations

Shallow excavations for the proposed structures 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 grade-supported improvements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades 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 construction, if applicable.

The groundwater table could affect overexcavation efforts, especially for overexcavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps may be necessary to achieve the recommended depth of overexcavation 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 review of 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.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow (strip/spread footings) foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Allowable Bearing Pressure [1, 2]	1,500 psf - foundations bearing upon structural fill
Required Bearing Stratum [3]	GeoModel Layer 1 and 2 or undisturbed native soils or structural fill extending to undisturbed native soil.
Minimum Foundation Dimensions	Per IBC 1809.7
Allowable Passive Resistance[4] **(Equivalent Fluid Pressures)**	300 pcf (cohesive backfill)

Item	Description
Sliding Resistance [5]	0.40 coefficient of friction
Minimum Embedment Below Finished Grade [6]	Footings: 12 inches, as applicable
Estimated Total Settlement from Structural Loads [2]	About 1 inch
Estimated Differential Settlement [2, 7]	About ½ of total settlement

1. The maximum allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The net allowable bearing pressure provided above include a factor of safety of at least 3.
2. Values provided are for maximum loads noted in **Project Description**. Additional geotechnical consultation will be necessary if higher loads are anticipated.
3. Unsuitable or soft soils should be overexcavated and improved per the recommendations presented in **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure. The passive pressure provided above include a factor of safety of at least 3.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are noted for equivalent-loaded foundations and bearing elevation as measured over a span of 50 feet.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., $e < b/6$, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

Item	Description
Soil Moist Unit Weight	120 pcf

Soil Effective Unit Weight[1]	58 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 20 degrees from vertical to ground surface

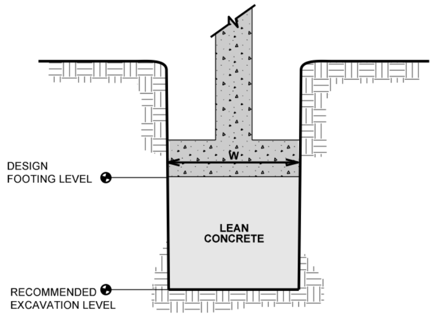
1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level. The high groundwater level should be used in uplift design as applicable.

Foundation Construction Considerations

As noted in **Earthwork**, the footing 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 footing excavations should be removed/reconditioned before foundation concrete is placed.

Sensitive soils exposed at the surface of footing excavations may require surficial compaction with hand-held dynamic compaction equipment prior to placing structural fill, steel, and/or concrete. Should surficial compaction not be adequate, construction of a working surface consisting of either crushed stone or a lean concrete mud mat may be required prior to the placement of reinforcing steel and construction of foundations.

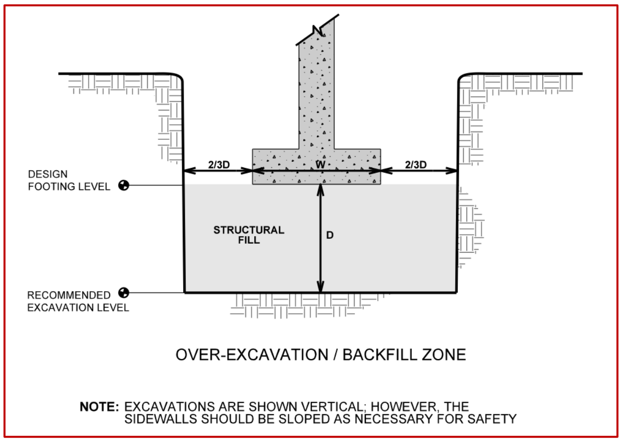
If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. The lean concrete replacement zone is illustrated on the sketch below.



LEAN CONCRETE BACKFILL

NOTE: EXCAVATIONS ARE SHOWN VERTICAL; HOWEVER, THE SIDEWALLS SHOULD BE SLOPED AS NECESSARY FOR SAFETY

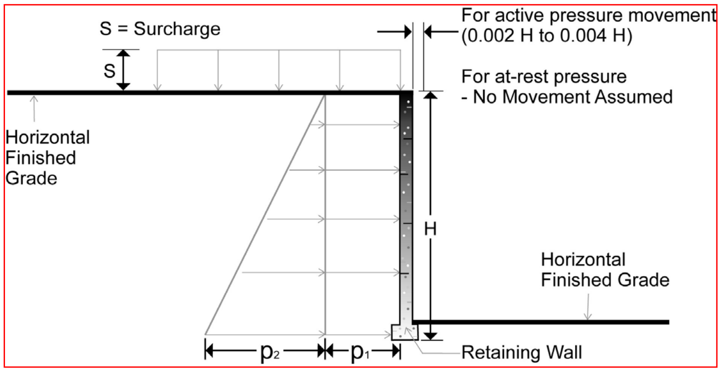
Overexcavation for structural fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation, with imported fill placed, as recommended in the **Earthwork** section.



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 [5]	Submerged [5]
Active (Ka)	Granular - 0.31 Fine Grained - 0.53	(0.31)S (0.53)S	(40)H (65)H	(80)H (90)H
At-Rest (Ko)	Granular - 0.47 Fine Grained - 0.69	(0.47)S (0.69)S	(60)H (80)H	(95)H (100)H
Passive (Kp)	Granular - 3.25 Fine Grained - 1.89	--- ---	(425)H (225)H	(280)H (170)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, wall must move horizontally to mobilize resistance. Fat clay or other expansive soils should not be used as backfill behind the wall.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf for cohesive soils (18° Ø) and 130 pcf for granular soils (32° Ø).
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

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 calculate the resistance to sliding, a value of 0.40 may be used as the ultimate coefficient of friction between the footing and the underlying soil.

Footings, floor slabs or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

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.

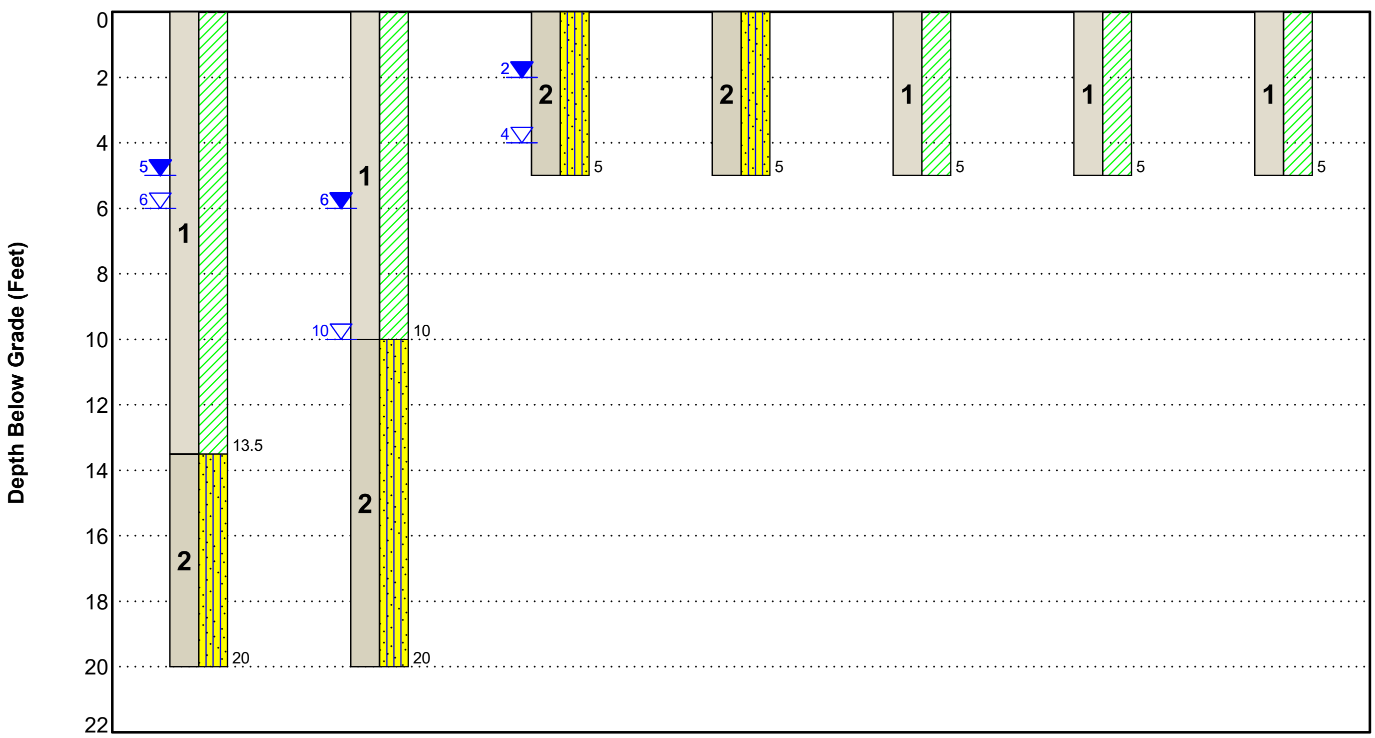
Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party 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 effect 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:

GeoModel



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

Model Layer	Layer Name	General Description
1	**Clay**	Lean Clay (CL); stiff to soft
2	**Sand**	Silty Sand (SM); very loose to loose

LEGEND

🟩 Lean Clay

🟨 Silty Sand

▽ First Water Observation

▽ Second Water Observation

▼ Third Water Observation

The groundwater 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.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Number of Borings	Approximate Boring Depth (feet)	Location
7	5 - 20	Proposed Wall Alignment

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 borings with a hand auger and 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 each boring and at intervals of 5 feet thereafter. 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 logs at the test depths. A 3-inch O.D. split-barrel sampling spoon with 2.5-inch I.D. ring lined sampler was used for soil sampling. For safety purposes, all borings were backfilled with auger cuttings after the groundwater observations were completed.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. 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 logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs 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

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

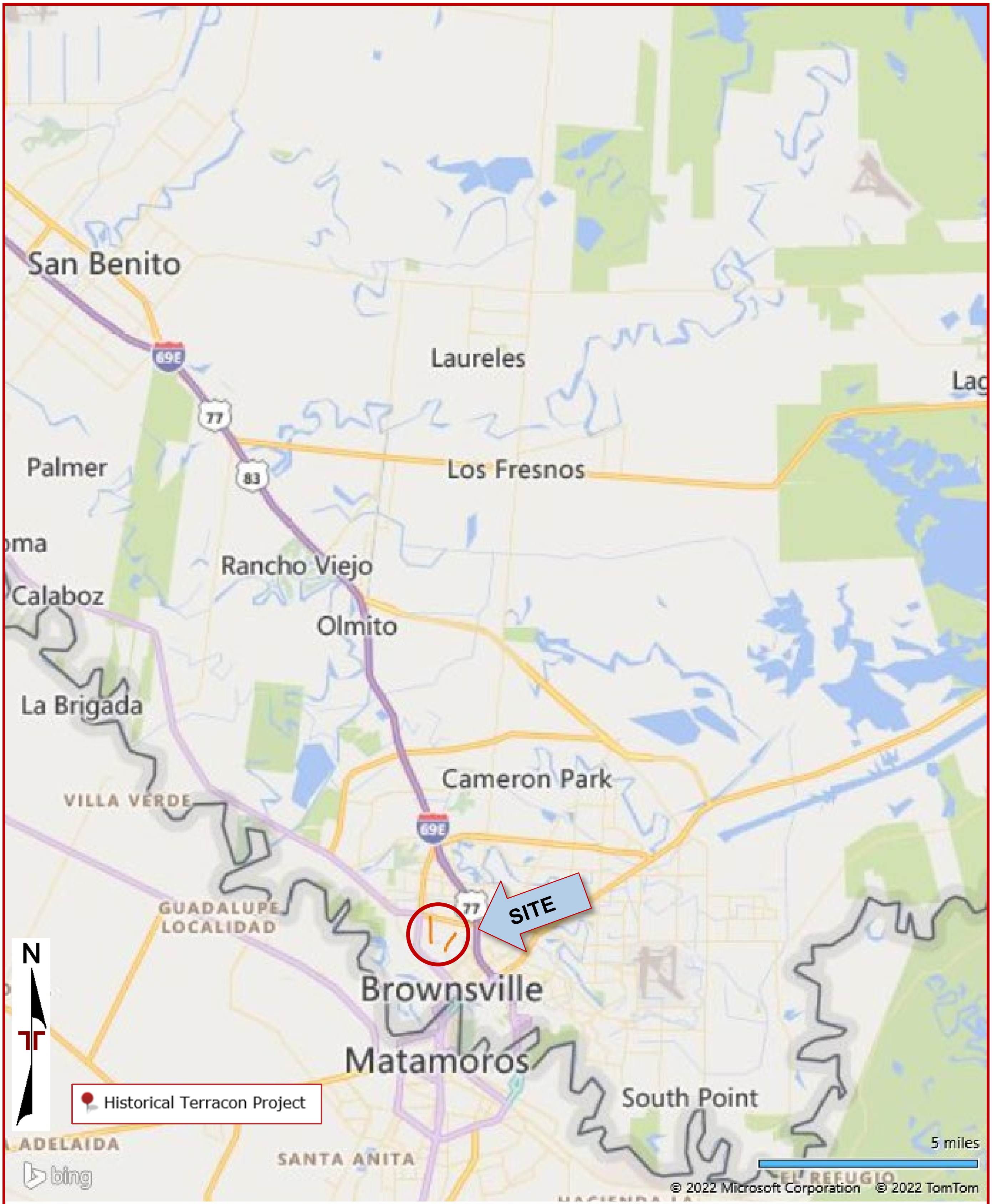


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Exploration Plan

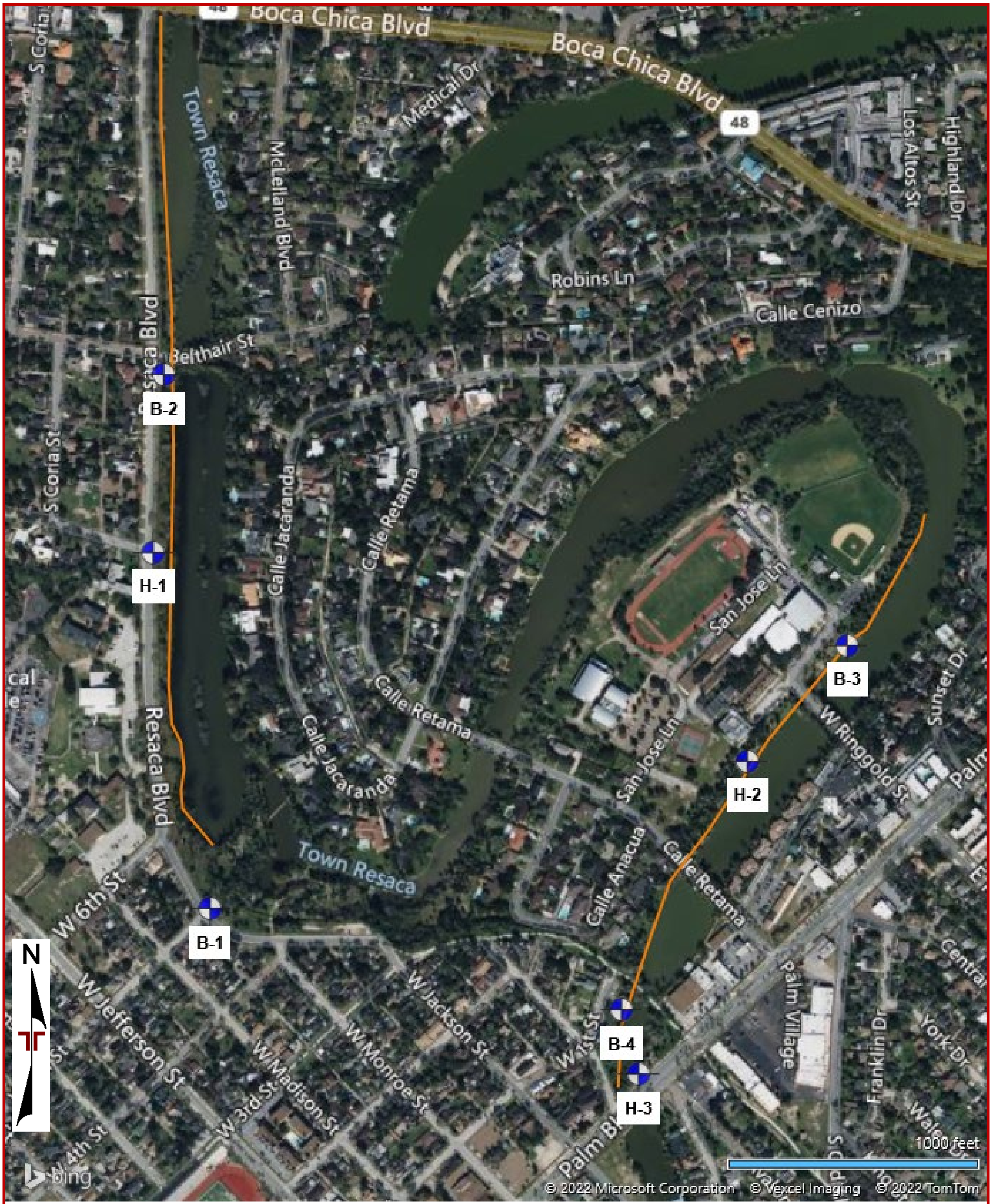


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Exploration and Laboratory Results

Contents:

Town Resaca Improvements
Resaca Boulevard | Brownsville, Texas
Terracon Project No. 88225178

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Log No. B-1

Location: See Exploration Plan

Latitude: 25.915610° Longitude: -97.507110°

Model Layer	Graphic Log	Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits: LL-PL-PI	Percent Fines
1		**LEAN CLAY (CL)**, grayish brown, stiff to soft			☒	6-4-6 N=10				24.7		39-19-20	
					☒	1-1-1 N=2				26.7			91
			5	▼ ▽	☒	1-2-3 N=5				22.9		40-18-22	
				▨	☒	2-3-5 N=8				31.4			97
			10		☒	1-1-2 N=3				33.8		47-17-30	
		13.5											
2		**SILTY SAND (SM)**, grayish brown, loose	15		☒	1-2-2 N=4				28.6			
			20		☒	2-2-3 N=5				28.1			15
		20.0											
		Boring Terminated at 20 Feet											

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

Water Level Observations
▽ 6 feet - While drilling
▽ 5 feet - After 15 minutes
▼ At completion of drilling
▨ Cave-In Depth

Advancement Method
Dry augered from 0 to 20 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

Terracon
1506 Mid Cities Dr
Pharr, TX

Boring Log No. B-2

Location: See Exploration Plan

Latitude: 25.921457° Longitude: -97.507676°

Model Layer	Graphic Log	Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	Percent Fines
							Test Type	Compressive Strength (tsf)	Strain (%)			LL-PL-PI	
1	▨	**LEAN CLAY (CL)**, with sand, grayish brown, medium stiff to soft, Fat Clay (CH) to 2 feet			☒	4-2-4 N=6				23.8		60-20-40	
	▨				☒	2-2-4 N=6				23.0			82
	▨		5	▼	☒	1-1-1 N=2				25.4		33-22-11	
	▨				☒	1-1-1 N=2				32.1			
	▨	10.0		▽	☒	1-2-2 N=4				29.6			78
2	▒	**SILTY SAND (SM)**, light brown, loose	10	▩									
	▒		15		☒	1-2-2 N=4				30.3			
	▒	20.0	20		☒	2-4-4 N=8				22.2			39

Boring Terminated at 20 Feet

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.

Water Level Observations

▽ 10 feet - While drilling

▽ 6 feet - After 15 minutes

▼ At completion of drilling

▩ Cave-In Depth

Notes

Advancement Method
Dry augered from 0 to 20 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

1506 Mid Cities Dr
Pharr, TX

Boring Log No. B-3

Location: See Exploration Plan

Latitude: 25.918490° Longitude: -97.499350°

Model Layer	Graphic Log	Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2		**SILTY SAND (SM)**, grayish brown, very loose to loose, Clayey Sand (SC) to 2 feet		▼	☒	1-2-1 N=3				28.9		35-16-19	
				▨	☒	1-1-2 N=3				36.2			
		5.0	5	▽	☒	1-2-3 N=5				24.7			15
		Boring Terminated at 5 Feet											

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.

Water Level Observations

▽	4 feet - While drilling
▽	2 feet - After 15 minutes
▼	At completion of drilling
▨	Cave-In Depth

Notes

Advancement Method
Dry augered from 0 to 5 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

1506 Mid Cities Dr
Pharr, TX

Boring Log No. B-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 25.914500° Longitude: -97.502100° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
2	▨	**SILTY SAND (SM)**, grayish brown, very loose to loose, Clayey Sand (SC) to 2 feet			☒	1-2-1 N=3				26.2		38-20-18	
					☒	1-2-3 N=5				35.7			
		5.0	5		☒	1-1-2 N=3				30.7			42
		Boring Terminated at 5 Feet											

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.

Water Level Observations
No free water observed

Notes

Advancement Method
Dry augered from 0 to 5 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
CME 75

Hammer Type
Automatic

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

Boring Log No. H-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 25.919505° Longitude: -97.507804° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	Percent Fines
							Test Type	Compressive Strength (tsf)	Strain (%)			LL-PL-PI	
1	▨	**LEAN CLAY (CL)**, grayish brown											
					✋					12.4		38-17-21	
					✋					24.2			93
					✋					32.1		44-17-27	
		5.0	5										
		Boring Terminated at 5 Feet											

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.

Water Level Observations
No free water observed

Drill Rig
Hand Auger

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

Notes

Advancement Method
Dry augered from 0 to 5 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Boring Log No. H-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 25.917222° Longitude: -97.500566° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1	▨	**LEAN CLAY (CL)**, with sand, grayish brown			✋					28.2		35-20-15	
	▨				✋					31.1			76
	▨	5.0	5		✋					38.5		32-19-13	
		Boring Terminated at 5 Feet											

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

Water Level Observations
No free water observed

Advancement Method
Dry augered from 0 to 5 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Drill Rig
Hand Auger

Driller
RGVD

Logged by

Boring Started
11-30-2022

Boring Completed
11-30-2022

Town Resaca Improvements
Resaca Boulevard | Brownsville, Texas
Terracon Project No. 88225178

1506 Mid Cities Dr
Pharr, TX

Boring Log No. H-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 25.913795° Longitude: -97.501892° Depth (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits	Percent Fines
							Test Type	Compressive Strength (tsf)	Strain (%)			LL-PL-PI	
1	▨	**LEAN CLAY (CL)**, grayish brown											
					✋					24.2		43-18-25	
					✋					23.0			91
		5.0	5		✋					23.8		38-16-22	
		Boring Terminated at 5 Feet											

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.

Water Level Observations
No free water observed

Drill Rig
Hand Auger

Driller
RGVD

Logged by

Notes

Advancement Method
Dry augered from 0 to 5 feet

Abandonment Method
Boring backfilled with soil cuttings upon completion.

Boring Started
11-30-2022

Boring Completed
11-30-2022

Supporting Information

Contents:

General Notes

Sampling	Water Level	Field Tests
✋ Grab Sample ☒ Split Spoon	▽ 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	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

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

[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.