Appendix F:

Geotechnical Engineering Report

Geotechnical Engineering Report

Cambria Hotel

Pleasant Hill, Contra Costa, California

July 6, 2018

Terracon Project No. ND185084

Prepared for:

Stratus Development Partners, LLC

Newport Beach, California

Prepared by:

Terracon Consultants, Inc.

Concord, California

July 6, 2018

Stratus Development Partners, LLC
17 Corporate Plaza, Suite 200
Newport Beach, California 92660

Attn: Mr. Andrew Wood - Partner
P: (949) 422 6231
E: awood@stratusdev.com

Re: Geotechnical Engineering Report
Cambria Hotel
3131 N. Main Street
Pleasant Hill, Contra Costa, California
Terracon Project No. ND185084

Dear Mr. Wood:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PND185084 dated June 1, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, pavements, a swimming pool, and floor slabs 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 Consultants, Inc.

PROFESSIONAL GEOLOGIST
RYAN L. COE
NO. 9421
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
NOAH T. SMITH
No. 2758
GEOTECHNICAL
STATE OF CALIFORNIA

Ryan Coe, P.G.
Senior Staff Geologist

Noah T. Smith, P.E., G.E.
Senior Associate

Terracon Consultants, Inc. 5075 Commercial Circle, Suite E Concord, California 94520
P (925) 609 7224 F (925) 609 6324 terracon.com

REPORT TOPICS

INTRODUCTION ... 1
SITE CONDITIONS ... 2
PROJECT DESCRIPTION ... 3
GEOTECHNICAL CHARACTERIZATION ... 4
GEOTECHNICAL OVERVIEW ... 6
EARTHWORK ... 7
SHALLOW FOUNDATIONS ... 15
MAT SLAB FOUNDATION ... 18
SEISMIC CONSIDERATIONS ... 19
LIQUEFACTION ... 20
FLOOR SLABS ... 21
LATERAL EARTH PRESSURES ... 24
PAVEMENTS ... 28
SWIMMING POOL ... 34
CORROSIVITY ... 35
GENERAL COMMENTS ... 37

Note: This report was originally delivered in a web-based format. **Orange 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 GeoReport logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS (Boring/CPT Logs and Laboratory Data)
SUPPORTING INFORMATION (General Notes, Unified Soil Classification System, CPT General Notes, and Liquefaction Results)

Geotechnical Engineering Report

Cambria Hotel
3131 N. Main Street
Pleasant Hill, Contra Costa, California
Terracon Project No. ND185084
July 6, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed hotel to be located at 3131 N. Main Street in Pleasant Hill, Contra Costa, California. The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Pavement design and construction
- Soil corrosivity
- Foundation design and construction
- Floor slab design and construction
- Liquefaction
- Lateral earth pressures
- Seismic site classification per 2016 CBC
- Swimming pool design and construction

The geotechnical engineering scope of services for this project included the advancement of 4 test borings to depths ranging from approximately 5 to 26½ feet below existing site grades (bgs) and two CPT soundings to depths of 39 and 50½ feet bgs. Terracon (formerly Neil O. Anderson & Associates) previously prepared a geotechnical engineering report for a proposed In-N-Out Burger restaurant at the site (Project No. WGE090523, Dated December 16, 2009). Information from our previous report was utilized.

Maps showing the site and boring/CPT locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section of this report.

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 at 3131 N. Main Street in Pleasant Hill, Contra Costa, California. The property is approximately 2.475 acres in size. 37.9326°N 122.0611° W (approximate) (See Exhibit D)
Existing Improvements	The northern part of the property is developed with a Black Angus Restaurant and a single-story retail building. The southernmost part of the property is undeveloped. The remaining portions of the property are developed with landscaping, asphalt paving and parking medians.
Current Ground Cover	Bare ground, asphalt paving and landscaping
Existing Topography (per GoogleEarth Pro)	The site is relatively level and varies in elevation from about 71 to 76 feet above Mean Sea Level (MSL).
Geology	The geology at the site is mapped as Quaternary Alluvium (Qa) which consists of alluvial gravel, sand and clay of valley areas[1] The material encountered in our borings and CPTs was generally consistent with the mapped geology in the area.

[1] Dibblee, T.W., and Minch, J.A., 2005, Geologic map of the Walnut Creek quadrangle, Contra Costa County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-149, scale 1:24,000

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. 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	A site plan of the proposed development was provided by Stratus Development Partners, LLC via email. Terracon (formerly Neil O. Anderson & Associates, Inc.) prepared a geotechnical engineering report for a proposed In-N-Out restaurant that was to be built at the site (Project No. WGE090523, Date December 16, 2009). We have reviewed our report in preparation of this project.
Project Description	Development will consist of the demolition of the existing restaurant and retail building and associated landscaping and paving to accommodate the construction of a new hotel and associated landscaping, parking and drives. Construction will include a swimming pool.
Proposed Structure	Four-story hotel with an approximate footprint of 25,000 square feet. The hotel will be approximately 49 feet tall.
Building Construction	Wood-frame with a slab-on-grade floor
Finished Floor Elevation	Unknown
Maximum Loads	■ Walls: 4 to 5 kips per linear foot (klf)
Grading/Slopes	We anticipate up to 2 feet of cut and fill may be required to develop final grade.
Below Grade Structures	Limited to the hotel elevator pit.
Free-Standing Retaining Walls	None anticipated
Pavements	Paved drives and parking will be constructed as part of development. We assume both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Please confirm this assumption. Anticipated traffic indices (TIs) are as follows: ■ Auto Parking Areas: TI = 5.0 ■ Auto Road: TI = 5.5 ■ Truck Parking Areas: TI = 6.0 ■ Truck Ramps and Roads: TI = 8.0 Average Daily Truck Traffic for rigid pavements ■ Car Parking and Access Lanes: ADTT = 1 (Category A) ■ Truck Parking: ADTT = 25 (Category B) ■ Dumpster Pads: per Category C The pavement design period is 20 years. Pavement design was based on an R-Value test result of 5 obtained from our Dec. 16, 2009 report.
Estimated Start of Construction	Fall 2018

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

The pavement sections encountered at our recent boring locations generally consisted of 2 inches of asphalt concrete over 4½ to 9 inches of aggregate base. Pavement sections encountered at the boring locations drilled in November 2009 generally consisted of 3 to 6 inches of asphalt concrete over 3 to 8 inches of aggregate base.

The material encountered in our borings generally consisted of interbedded layers of stiff lean clay with varying amounts of silt and sand, stiff to very stiff fat clay, and very loose to medium dense sand with varying amounts of silt and clay to a maximum depth explored of 26½ feet below ground surface (bgs). The material encountered by our CPT soundings was generally consistent with the material encountered in our borings. CPT-01 and CPT-02 both encountered refusal at 37.8 feet bgs and 50.5 feet bgs, respectively, in gravelly sand material.

Conditions encountered at each boring/CPT location are indicated on the individual boring/CPT logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring/CPT logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes and CPTs can be found on the boring/CPT logs in **Exploration Results**, and are summarized below.

Boring/CPT Number	Approximate Depth to Groundwater while Drilling (feet) [1]
B1	13
B2	18
CPT-01 [2]	18
CPT-02[2]	18

1. Below ground surface
2. Interpreted from results of pore pressure dissipation test

Groundwater was not observed in the remaining borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater, or the water levels summarized above are stable groundwater levels. Due to the low permeability of soils encountered in the borings, a relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater was encountered at depths of 10 to 10½ feet bgs in our previous borings drilled at the site on November 18, 2009 and November 19, 2009.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings/CPTs were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring/CPT logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The subject site has several geotechnical considerations that will affect the construction and performance of the proposed hotel. The following geotechnical considerations have been identified at the subject site:

- Compressible soil considerations
- Moderately plastic clay considerations

Compressible Soil Considerations

The subject soils within the influence of the planned building generally consist of loose to medium dense sand with variable amounts of silt and stiff clay with variable amounts of silt and sand that are susceptible to excessive settlement/consolidation under planned loading conditions. Excessive settlement/consolidation can result in damage to the proposed improvements. In order to help mitigate the effects of the anticipated settlement/consolidation we recommend the building be supported by a **Mat Slab Foundation** system underlain by 18 inches of low volume change (LVC) material or **Shallow Foundations** bearing on a minimum 24 inches of controlled low strength material (CLSM), lean grout slurry.

Moderately Plastic Clay Considerations

As indicated, the surficial soils within the footprint of the planned building generally consist of both loose to medium dense sand variable amounts of silt and stiff clay with varying amounts of silt and sand. Based on laboratory testing the surface clays are moderately plastic. Boring B2 encountered highly expansive, fat clay at a depth of 9½ feet bgs. Additional areas of localized moderately to highly plastic clays may be present in the building area where borings/CPTs were not performed.

These plastic clays are prone to volume change with changes in moisture which may lead to excessive shrinking and swelling of slabs. In order to address the effects of the high volume change soils, we recommend **Floor Slabs** be underlain by a minimum of 18 inches of low volume change (LVC) material or bear on 12 inches of soil chemically (lime/cement) treated soil. Using an LVC zone or chemically treating the upper 12 inches of building pad as recommended in this report may not eliminate all future subgrade volume change and resultant slab movements. However, the procedures outlined herein should help to reduce the potential for subgrade volume change.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and cracking in the building should be anticipated. The severity of cracking and other (cosmetic) damage such as uneven slabs will likely increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more extensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request.

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

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork will include demolition, 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, floor slabs, and pavements.

Site Preparation

The proposed construction area is an active restaurant that was improved with paved parking areas, concrete slabs, and a single-story wood framed building at the time of our investigation. All existing debris, debris generated from demolition of the existing restaurant and pavements, vegetation, underground utilities, and other deleterious materials should be stripped and removed from the site. This should include the removal of any buried concrete slabs, or buried footings that may exist within the area of the proposed construction. Aggregate base from stripped pavement sections may be stockpiled for use as engineered fill provided it remains clean and free of debris. Exposed surfaces should be free of mounds and depressions, which could prevent uniform compaction.

The subgrade should be proof-rolled with an adequately loaded vehicle such as a fully loaded tandem axle dump truck. The proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed or modified by stabilizing as noted in the following section **Soil Stabilization**. Excessively wet or dry material should either be removed or moisture conditioned and recompacted.

Subgrade Preparation

We understand the site grade will remain at the same elevation present at the time of our field work and that any cuts and fills required will be to process the existing grades for construction. If site grades will be raised, Terracon should be contacted to provide additional recommendations as necessary.

After clearing any required cuts should be made. Once any required cuts have been made, and prior to placing any fill, the subgrade soil should be scarified and compacted. The depth of scarification of subgrade soils and moisture conditioning of the subgrade is highly dependent on the time of year of construction and the site conditions that exist immediately prior to construction. If construction occurs during the winter or spring, when the subgrade soils are typically already in a moist condition, scarification and compaction may only be 12 inches. If construction occurs during the summer or fall when the subgrade soils have been allowed to dry out deeper, the depth of scarification and moisture conditioning may be as much as 18 inches. A representative from Terracon should be present to observe the exposed subgrade and specify the depth of scarification and moisture conditioning required.

The moisture content and compaction of subgrade soils should be maintained until foundation/slab/pavement construction. Care should be taken to prevent wetting or drying of the bearing materials during construction.

Soil Stabilization

Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, and removal of unstable materials and replacement with granular fill (with or without geosynthetics). The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of the area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help to reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proof rolling operations, it could be stabilized using one of the methods outlined below.

- **Scarification and Compaction** – It may be feasible to scarify, dry, and compact the exposed soils. The success of this procedure would depend primarily upon favorable weather and sufficient time to dry the soils. Stable subgrades likely would not be achievable if the thickness of the unstable soil is greater than about 1 foot, if the unstable soil is at or near groundwater levels, or if construction is performed during a period of wet or cool weather when drying is difficult.

- **Aggregate Base** – The use of Caltrans Class II aggregate base is the most common procedure to improve subgrade stability. Typical undercut depths would be expected to range from about 6 to 18 inches below finished subgrade elevation with this procedure. The use of high modulus geotextiles (i.e., engineering fabric or geogrid) could also be considered after underground work such as utility construction is completed. Prior to placing the fabric or geogrid, we recommend that all below-grade construction, such as utility line installation, be completed to avoid damaging the fabric or geogrid. Equipment should not be operated above the fabric or geogrid until one full lift of aggregate base is placed above it. The maximum particle size of granular material placed over geotextile fabric or geogrid should meet the manufacturer's specifications.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill and general fill. Structural fill is material used below, or within 5 feet of structures, pavements or constructed slopes. General fill is material used to achieve grade outside of these areas. Earthen materials used for structural and general fill should meet the following material property requirements:

Fill Type[1]	USCS Classification	Acceptable Location for Placement
Lean Clay	CL (LL<40)	All structural and general locations and elevations, except as LVC material unless material explicitly meets LVC requirements.
Moderate to High Plasticity Material[2]	CL (LL≥40 or PI≥25)	All general fill locations and elevations
Well-graded Granular[3]	GM, SM, SP	All structural and general locations and elevations
Low Volume Change (LVC) Material[4]	CL, SC (LL<30 & PI<10) or Well-graded Granular Material [3]	All structural and general locations and elevations
On-site Soils[5]	SW, SP	All structural and general fill locations and elevations
	CL, CL-ML	As noted above
	CH	Should not be used as fill

1. Compacted structural fill should consist of approved materials that are free of organic matter and debris. A sample of each material type should be submitted to Terracon for evaluation at least 2 weeks prior to construction.
2. Delineation of moderate to highly plastic clays should be performed in the field by a qualified geotechnical engineer or their representative, and could require additional laboratory testing.
3. Caltrans Class II aggregate base may be used for this material.
4. Low plasticity cohesive soil or granular soil having low plasticity fines. Material should be approved by the geotechnical engineer.
5. This material should be removed and recompacted if used as an engineered or structural fill as described in section **Fill Compaction Requirements**.

Fill Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness[2]	8 inches or less 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
Minimum Compaction Requirements [1,3]	90% of max. above foundations 95% of max. below foundations and floor slabs, and in the upper 12 inches of subgrade in pavement areas, and for aggregate base	90% of max.
Water Content Range [1]	Low plasticity cohesive (PI<10): +1% to +3% above optimum High plasticity cohesive (PI>10): +2% to +4% above optimum Granular: -2% to +2% of optimum	As required to achieve min. compaction requirements[4]

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D 1557).
2. Reduced lift thicknesses are recommended in confined areas (e.g., utility trenches, foundation excavations, and foundation backfill) and when hand-operated compaction equipment is used.
3. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved. This procedure is intended for soils with 30 percent or less material larger than ¾ inch. Accordingly, we recommend full time proof roll observation be performed instead of moisture density testing for materials containing more than 30 percent aggregate retained on the ¾-inch sieve.
4. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof rolled.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cementitious flowable fill or cohesive fill in non-pavement areas to reduce the infiltration and conveyance of surface water through the trench backfill. Attempts should also be made to limit the amount of fines migration into the clean granular material. Fines migration into clean granular fill may result in unanticipated localized settlements over a period of time. To help limit the amount of fines migration, Terracon recommends the use of a geotextile fabric that is designed to prevent fines migration in areas of contact between clean granular material and fine-grained soils. Terracon also recommends that clean granular fill be tracked or tamped in place where possible in order to limit the amount of future densification which may cause localized settlements over time.

Utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the guest house. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Post construction trenching through geogrid in the pavement areas shall be accomplished with conventional trenching equipment. Repairs to the trenched section shall be accomplished using a full structural replacement of the displaced materials or with a repaired section that is identical to the original section. If the trench section is repaired to match the original, the trench backfill must be compacted to the same or higher density and the geogrid must be over-lapped a minimum 3-inches at the proper geogrid elevation.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5 percent away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary as part of the structure's maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Planters and bio-swales located within 10 feet of structures should be self-contained or lined with an impermeable membrane to prevent water from accessing building subgrade soils. Sprinkler mains and spray heads should be located a minimum of 5 feet away from the building lines.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the structures. Trees and shrubbery should be kept away from the exterior of the structures a distance at least equal to their expected mature height.

Implementation of adequate drainage for this project can affect the surrounding developments. Consequently, in addition to designing and constructing drainage for this project, the effects of site drainage should be taken into consideration for the planned structures on this property, the undeveloped portions of this property, and surrounding sites. Extra care should be taken to ensure irrigation and drainage from adjacent areas do not drain onto the project site or saturate the construction area.

Earthwork Construction Considerations

Excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to floor slab or pavement construction.

We recommend that the earthwork portion of this project be completed during extended periods of dry weather if possible. If earthwork is completed during the wet season (typically November through April) it may be necessary to take extra precautionary measures to protect subgrade soils. Wet season earthwork operations may require additional mitigation measures beyond that which would be expected during the drier summer and fall months. This could include ground stabilization utilizing chemical treatment of the subgrade, diversion of surface runoff around exposed soils, and draining of ponded water on the site. Once subgrades are established, it may be necessary to protect the exposed subgrade soils from construction traffic.

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.

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 old structures, vegetation and top soil, proof-rolling and mitigation of areas delineated by the proof-roll to require mitigation.

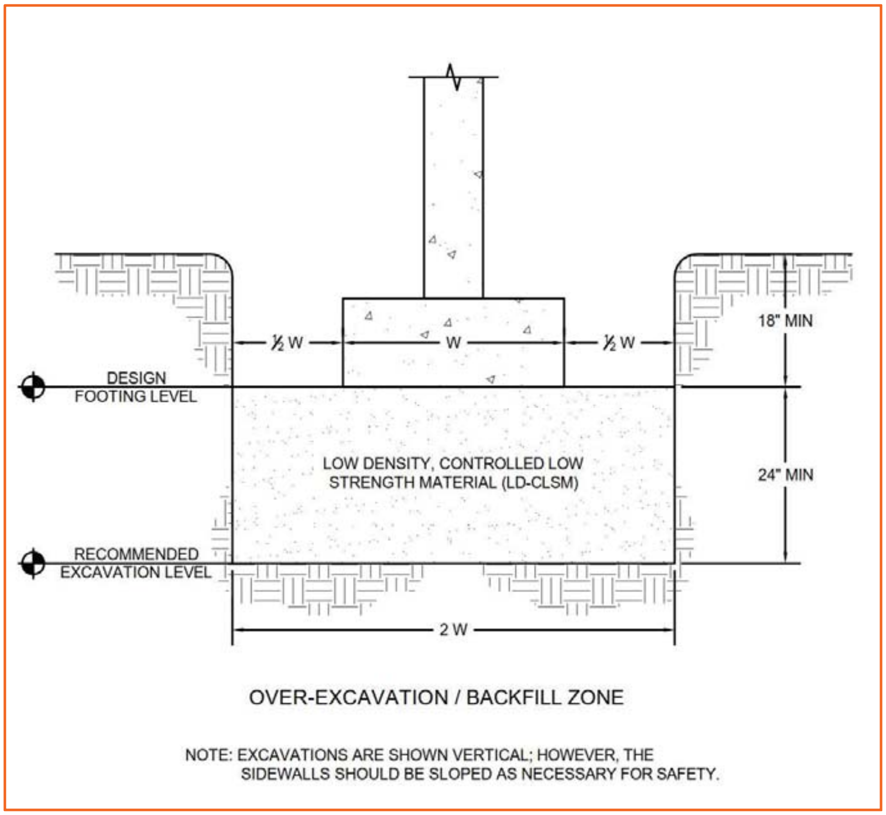
Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building and pavement areas. One density and water content test per lift should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation and swimming pool excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that 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.

SHALLOW FOUNDATIONS

Shallow foundations may be utilized at this site provided the footings bear on a minimum 24 inches of controlled low strength material (CLSM). For the CLSM placement, the footing excavations should be over-excavated a minimum 24 inches below the planned design depth of the of the footings. The over-excavated area should be twice the width of the planned footing as shown below.



Following over-excavation, CLSM should be backfilled up to the design depth of the footing. The CLSM should have a minimum compressive strength of 300 psi and should have a maximum unit weight of 100 pound per cubic foot (pcf). CLSM should be mixed and placed per the latest version of ACI 229R Report on Controlled Low-Strength Materials.

Provided **Earthwork** has been performed as recommended herein and the perimeter footing excavations have been prepared as indicated, the following design parameters are applicable for **Shallow Foundations**.

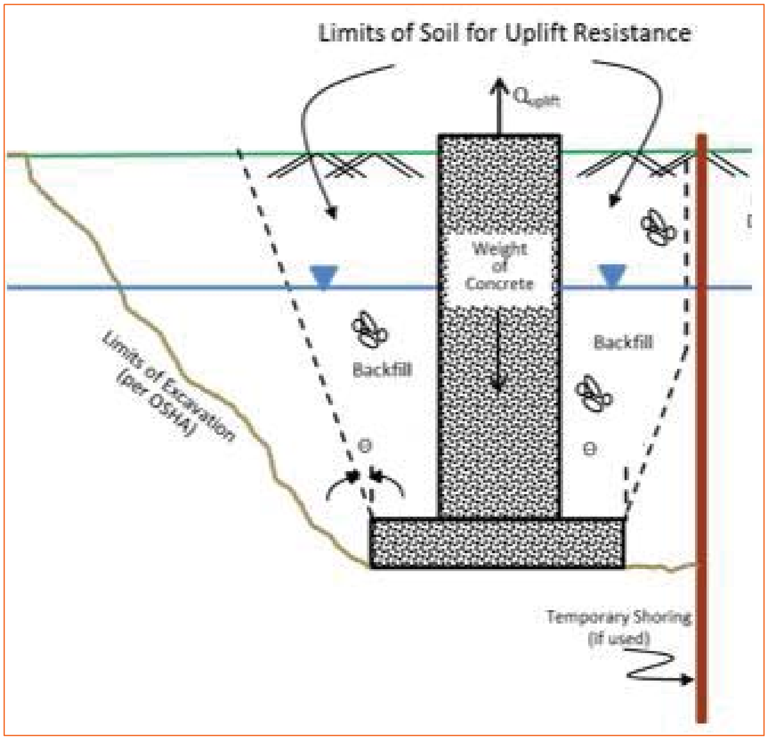
Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	1,800 psf
Required Bearing Stratum	24 inches minimum CLSM
Minimum Foundation Width	12 inches – strip footings 18 inches – pad footings
Maximum Foundation Width	48 inches
Ultimate Passive Resistance [3,7] **(equivalent fluid pressures)**	300 pcf
Ultimate Coefficient of Sliding Friction [4,7]	0.35
Minimum Embedment below Finished Grade [5]	18 inches
Estimated Static Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Static Differential Settlement [2, 6]	About 1/2 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in **Project Description**. Values do not include settlement due to liquefaction.
3. 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.
4. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
5. Embedment necessary to minimize the effects of seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
6. Differential settlements are as measured over a span of 40 feet.
7. Passive pressure and sliding friction may be combined to resist sliding provided the passive pressure is reduced by 50 percent.

Design Parameters - Uplift Loads

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils. As illustrated on the subsequent figure, the effective weight of the soil prism defined by diagonal planes extending up from the top of the perimeter of the foundation to the ground surface at an angle, θ, of 20 degrees from the vertical can be included in uplift resistance. The maximum allowable uplift capacity should be taken as a sum of the effective weight of soil plus the dead weight of the foundation, divided by an appropriate factor of safety. A maximum total unit weight of 100 pcf should be used for the backfill.



Foundation Construction Considerations

As noted in **Earthwork**, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete or CLSM should be placed soon after excavating to reduce bearing soil disturbance and minimize water infiltration into the excavation. 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 or CLSM is placed.

To ensure foundations have adequate support, special care should be taken when footings are located adjacent to trenches. The bottom of such footings should be at least 1 foot below an imaginary plane with an inclination of 1.5 horizontal to 1.0 vertical extending upward from the nearest edge of the adjacent trench.

MAT SLAB FOUNDATION

As an alternative to **Shallow Foundations** the hotel may be supported by a **Mat Slab Foundation** system. The following design parameters are applicable for a mat slab foundation.

Item	Description
Maximum Net Allowable Bearing pressure [1, 3]	300 psf
Required Bearing Stratum [4]	18 inches LVC structural fill
Ultimate Passive Resistance [5,8] **(equivalent fluid pressure)**	300 pcf
Ultimate Coefficient of Sliding Friction [6,8]	0.30
Estimated Total Static Settlement from Structural Loads [3]	Up to 1 inch
Estimated Static Differential Settlement [3,7]	Up to 5/8 inch over 40 feet
Design Modulus of Subgrade Reaction, k	80 pci

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. An appropriate factor of safety has been applied. These bearing pressures can be increased by 1/3 for transient loads unless those loads have been factored to account for transient conditions. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. No isolated footings shall be used. All footings shall be structurally tied together with mat or tie beams.
3. Values provided are for maximum loads noted in **Project Description**. Values do not include settlement due to **Liquefaction.**
4. Unstable or soft soils should be over-excavated and replaced according to the recommendations present in **Earthwork.**
5. Use of passive earth pressures require the sides of the excavation for the foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the foundation forms be removed and compacted structural fill be placed against the vertical foundation face.
6. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
7. Differential settlements are as measured over a span of 40 feet.
8. Passive pressure and sliding friction may be combined to resist sliding provided the passive pressure is reduced by 50 percent.

The mat slab should be designed to span a distance of 10 feet and cantilever a distance of 5 feet. The subgrade soils should be in an above optimum moisture condition at the time the slab foundation is poured and should be checked by a representative from Terracon.

Since there are several factors that will control the design of mat foundations besides vertical load, Terracon should be consulted when the final foundation depth and width are determined to assist the structural designer in the evaluation of anticipated settlement.

Other details including treatment of loose foundation soils, superstructure reinforcement and observation of foundation excavations as outlined in the **Earthwork** section of this report are applicable for the design and construction of a mat slab foundation at the site.

SEISMIC CONSIDERATIONS

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 7-10.

Description	Value
2016 California Building Code Site Classification (CBC) [1]	D[2]
Site Latitude	37.9326°N
Site Longitude	122.0611°W
S_s, Spectral Acceleration for a Short Period [3]	1.745g
S_1, Spectral Acceleration for a 1-Second Period [3]	0.610g
F_a, Site Coefficient [3]	1.0
F_v, Site Coefficient (1-second period) [3]	1.5
S_{DS}, Spectral Acceleration for a Short Period [3]	1.163g
S_{D1}, Spectral Acceleration for a 1-Second Period [3]	0.610g

1. Seismic site classification in general accordance with the *2016 California Building Code*.
2. The 2016 California Building Code (CBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested includes a 100-foot soil profile determination. However, CPT's for this project extended to a maximum depth of approximately 50.5 feet where they realized shallow refusal. This seismic site class assignment considers that stiff/dense soil continues below the maximum depth of the subsurface exploration. Additional exploration to greater depths could be considered to confirm the conditions below the current depth of exploration. Alternatively, a geophysical exploration could be utilized in order to attempt to justify a more favorable seismic site class.
3. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

Faulting and Estimated Ground Motions

The site is located in the northern San Francisco Bay Area of California, which is a relatively high seismicity region. The type and magnitude of seismic hazards affecting the site are dependent on the distance to causative faults, the intensity, and the magnitude of the seismic event. The following table indicates the distance of the fault zones and the associated maximum credible earthquake that can be produced by nearby seismic events, as calculated using the USGS Unified

Hazard Tool. Segments of the Green Valley Fault, which is located approximately 5½ kilometers from the site, are considered to have the most significant effect at the site from a design standpoint.

Characteristics and Estimated Earthquakes for Regional Faults			
Fault Name	**Approximate Contribution (%)**	**Approximate Distance to Site (kilometers)**	**Maximum Credible Earthquake (MCE) Magnitude**
bFault.ch: Green Valley Connected	36.29	5.47	6.68
bFault.ch: Mount Diablo Thrust	13.16	10.29	6.59
bFault.gr: Green Valley Connected	24.54	5.50	6.59
bFault.gr: Mount Diablo Thrust	7.83	10.29	6.54

Based on the ASCE 7-10 Standard, the peak ground acceleration (PGA_M) at the subject site is approximately 0.663g. Based on the USGS 2008 interactive deaggregations, the PGA at the subject site for a 2% probability of exceedance in 50 years (return period of 2475 years) is expected to be about 0.852g.

The site is not located within an Alquist-Priolo Earthquake Fault Zone based on our review of the State Fault Hazard Maps.[2]

LIQUEFACTION

Liquefaction is a mode of ground failure that results from the generation of high pore water pressures during earthquake ground shaking, causing loss of shear strength. Liquefaction is typically a hazard where loose sandy soils or low plasticity fine grained soils exist below groundwater. The California Geologic Survey (CGS) has designated certain areas within California as potential liquefaction hazard zones. These are areas considered at a risk of liquefaction-related ground failure during a seismic event, based upon mapped surficial deposits and the presence of a relatively shallow water table. The project site and surrounding area is located within a liquefaction hazard zone designated as having moderate susceptibility to liquefaction. Therefore, a liquefaction analysis was performed to determine the liquefaction induced settlement.

[2] California Department of Conservation Division of Mines and Geology (CDMG), *"Digital Images of Official Maps of Alquist-Priolo Earthquake Fault Zones of California, Southern Region"*, CDMG Compact Disc 2000-003, 2000.

Groundwater was observed in our borings at the time of field exploration at depths varying from 13 to 18 feet bgs. Groundwater was observed in our borings drilled at the site in November 2009 at depths varying from 10 to 10½ feet bgs.

A liquefaction analysis was performed in general accordance with California Geologic Survey Special Publication 117. The liquefaction study utilized the software “LiquefyPro” by CivilTech Software and “CLiq” by GeoLogismiki Geotechnical Software. This analysis was based on the soil data from the CPT soundings. A Peak Ground Acceleration (PGA) of 0.663g and a mean magnitude of 6.63 for the project site was used. Analysis were performed on data obtained from both CPT1 and CPT2. CPT calculations were assessed using the Robertson (NCEER 2001), Robertson (2009), Idriss & Boulanger (2008), and Boulanger & Idriss (2014) methods. Settlement analysis in the “LiquefyPro” software was performed using the Ishihara/Yoshimine and method.

A liquefaction potential analysis was calculated from a depth of 10 to 50 feet below the ground surface. Based on the analysis, liquefiable layers most susceptible to liquefaction potential were encountered between the depths of approximately 18 to 21 feet bgs and 27 to 32 feet bgs. Due to the cohesive nature and thickness of non-liquefiable soils across the surface of the site, we believe the probability for liquefaction to manifest at the surface is low. However, based on our review of the calculations by the various methods, the anticipated potential total liquefaction-induced settlement is on the order of ½ to ¾ inches. Actual settlement could vary by a factor of 2. The differential liquefaction-induced settlement may be considered to be half the total liquefaction induced settlement. Since the project site is relatively level ground, the potential for lateral spreading is considered to be low.

We anticipate a brief loss of shear strength during a significant seismic event where liquefaction may occur. The bearing strength and vertical and lateral stiffness of the subsurface soils will be reduced to the residual shear strength of the liquefiable layer, causing the anticipated settlement noted above.

Accurate evaluation of the effects of liquefaction-induced instability requires accurate estimation of the shear strength of the liquefied soils. Terracon should be consulted to evaluate the subsurface conditions and foundation capacities after a significant event where liquefaction has occurred.

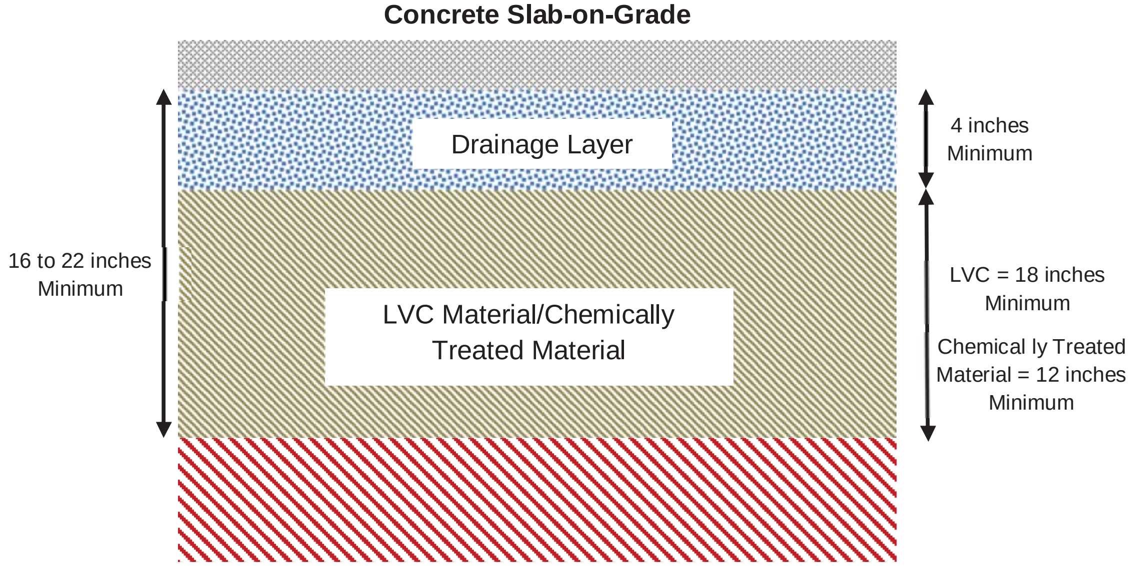
FLOOR SLABS

The surficial soils within the footprint of the planned building generally consist of both loose to medium dense sand with gravel and stiff lean clay with varying amounts of sand. Based on laboratory testing the clays are moderately plastic. Additional areas of localized moderately to highly plastic clays may be present in the building area where borings/CPTs were not performed. In order to help mitigate the effects of the plastic soils on slabs we recommend interior and exterior slabs be underlain by a minimum of 18 inches of low volume change (LVC) material or bear on 12 inches of chemically (lime/cement) treated soil. Using an LVC zone or chemically treating the upper 12 inches of building pads as recommended in this report may not eliminate all future subgrade volume change and resultant slab movements. However, the procedures outlined herein should help to reduce the potential for subgrade volume change.

Chemical treatment involves treating the building pad subgrade soils with a certain percentage of high calcium quicklime and/or cement, usually 3.5 to 5 percent based on the dry unit weight of the soil, for a depth of 12 inches. For estimating purposes, we recommend using 2.25 percent lime and 2.25 percent cement and a soil unit weight of 110 pounds per cubic foot. For a 12-inch treatment depth, this results in an estimated minimum spread rate of 2.5 pounds per square foot lime and 2.5 pounds per square foot cement. The actual amount of lime/cement to be used should be determined by Terracon and by laboratory testing **at least two weeks prior** to the start of grading operations. Chemical treatment is performed after rough grading is completed.

LVC fill should be placed and compacted as recommended in section **Earthwork.** Terracon should be present during grading to help delineate the areas where moderately to highly plastic clays are present. Due to the potential for significant moisture fluctuations of subgrade material beneath floor slabs supported at-grade, the Geotechnical Engineer should evaluate the material below the bottom of the LVC zone immediately prior to placement of additional fill or floor slabs. Soils below the specified water contents within this zone should be moisture conditioned or replaced with structural fill as stated in our **Earthwork** section.

Concrete Slab-on-Grade



Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and. positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	At least 18 inches of low volume change (LVC) material as described for structural fill in the **Fill Material Types** section or 12 inches of chemically treated material.
Estimated Modulus of Subgrade Reaction [2]	80 pounds per square inch per inch (psi/in)
Capillary Break Layer Thickness [3, 4]	Minimum 4 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 95% of ASTM D 698

1. Floor slabs should be structurally independent of building foundations or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table.
3. Free-draining granular material should have less than 5 percent fines (material passing the #200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.
4. These granular materials are in addition to the LVC zone or chemically treated material.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Floor Slab Construction Considerations

Finished subgrade within and for at least 10 feet beyond the floor slab should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

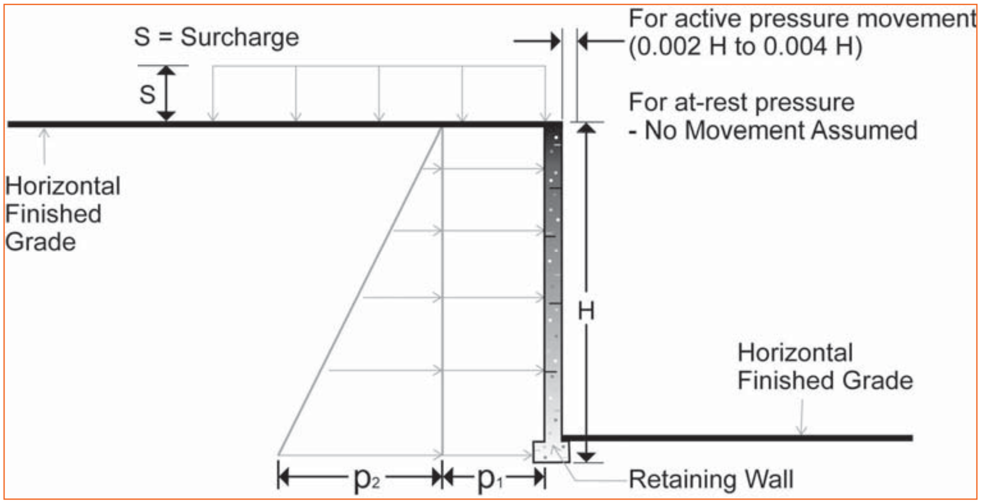
The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

The lateral earth pressure recommendations given in the following paragraphs are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls. Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop recommendations for the design of such wall systems upon request.

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. 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, 4, 5] **p_1 (psf)**	**Effective Fluid Pressures (psf)** [2, 4, 5]	
			Unsaturated [6]	**Submerged** [6]
Active (Ka)	Structural granular fill - 0.31	(0.31)S	(40)H	(80)H
	Native Soil - 0.53	(0.53)S	(65)H	(95)H
At-Rest (Ko)	Structural granular fill - 0.47	0.47)S	(55)H	(90)H
	Native Soil - 0.69	(0.69)S	(85)H	(105)H
Passive (Kp)	Structural granular fill – 3.25	---	(390)H	(250)H
	Native Soil – 1.89	---	(225)H	(175)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.
2. Uniform, horizontal backfill, compacted to at least 90 percent of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. In order 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 structural granular fill values to be valid, the structural granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

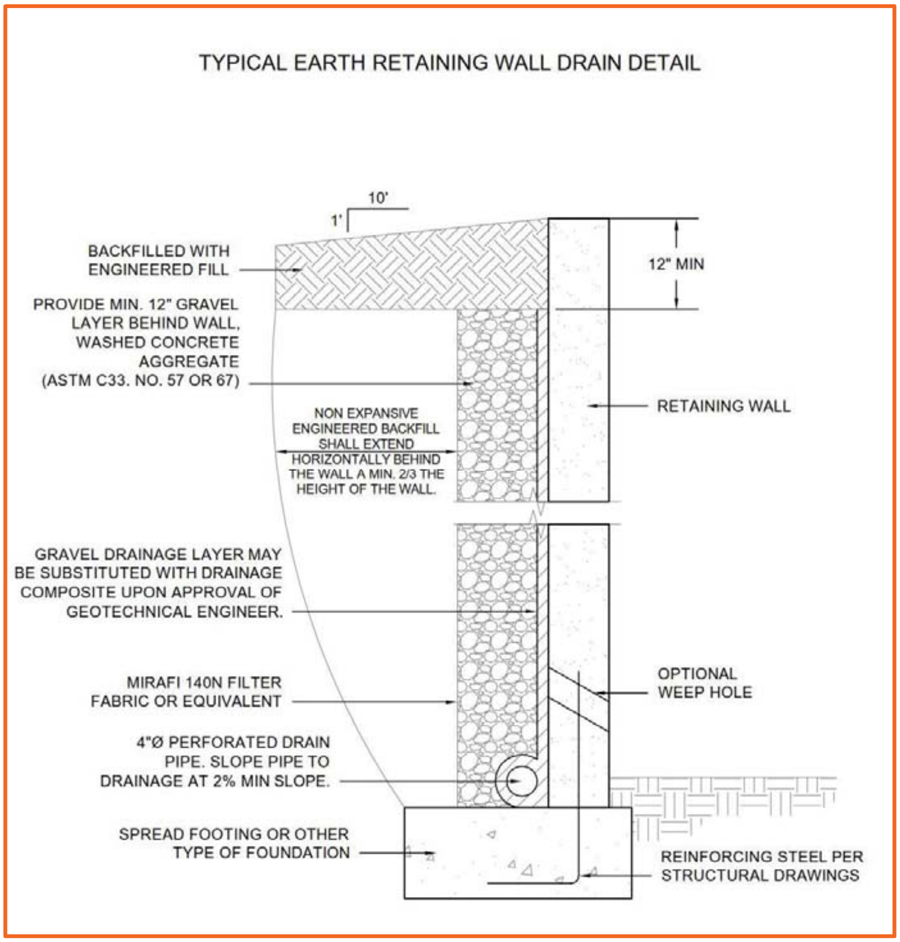
Total lateral earth pressures acting on retaining wall during a seismic event will likely include the active or at-rest static forces and a dynamic increment. The active dynamic increment should be applied to the wall as resultant force acting at 0.6H height from the base of the wall and the at-rest dynamic increment should be applied to the wall as resultant force acting at 0.63H height from the base of the wall. Such increments should be added to the static earth pressures. A dynamic lateral earth resultant force of $10H^2$ (in units of pounds per linear foot (plf), where H (in units of feet) is the height of the soil behind the wall[3] should be used in design.

Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures which could result in wall movement.

Retaining Wall Drainage

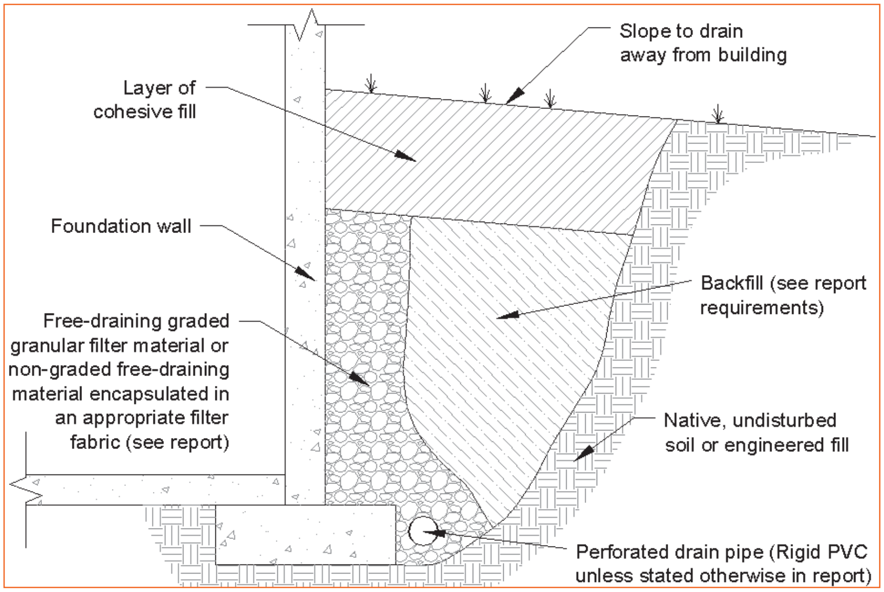
To control hydrostatic pressure behind the wall we recommend that a drain be installed at the bottom of the wall with a collection pipe leading to a reliable discharge. The drainage should consist of either a composite drain or a 12-inch thick free draining gravel blanket. Free draining gravel should consist of Caltrans Class II permeable material or ¾ inch clean gravel wrapped in Mirafi 140N filter fabric or equivalent. The drainage should extend from the bottom of the wall to within 12 inches of the top of the wall. The drainage should be capped with 12 inches of compacted cohesive soil. The collection pipe should be designed by the Civil Engineer but should be a minimum 4-inch diameter perforated Schedule 40 PVC or ABS drain pipe and should slope to an existing drainage system or to a positive gravity outlet. A typical earth retaining wall drain detail is illustrated on the following sketch.

[3] *Seed & Whitman (1970)*



Subsurface Drainage for Below Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5 percent passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs, noted in this section, must be applied to the site, which has been prepared as recommended in the **Earthwork** section.

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrades, initially prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 10 inches of the subgrade be evaluated and the pavement subgrades be proofrolled within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills.

After proof rolling and repairing deep subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in the **Earthwork** section this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

Support characteristics of subgrade for pavement design do not account for shrink/swell movements of an expansive clay subgrade, such as soils encountered on this project. Thus, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

Pavement Design Parameters

Design of Asphaltic Concrete (AC) pavement sections were calculated using the Caltrans Highway Design Manual, latest edition, and a 20-year design life. Design of Portland Cement Concrete (PCC) pavement sections were designed using ACI 330R-08, "Guide for the Design and Construction of Concrete Parking Lots."

During the previous investigation at the site, one sample of the near surface soil taken from our borings was tested in a Terracon laboratory to determine the Hveem Stabilometer Value (R-value). The test produced an R-value of less than 5. A design R-Value of 5 was used to calculate the AC pavement thickness sections. A modulus of subgrade reaction of 50 pci was use for the PCC pavement designs. The values were empirically derived based upon our experience with the describe soil type subgrade soils and our understanding of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. A modulus of rupture of 550 psi was used for pavement concrete.

Based on this relatively low R-value the conventional pavement sections will be relatively thick. The deeper pavement sections will require more off haul of material on site if the same grades are kept. As an alternative to conventional pavement sections, reinforcing the pavement sections with geogrid or chemical treatment of the subgrade soils may be performed to improve their physical support characteristics and reduce the pavement section.

Recommendations for conventional, geogrid reinforced, and chemically treated pavement sections are presented below.

Pavement Section Thicknesses

The following tables provide options for AC, AC with geogrid reinforcement, AC with chemical treatment and PCC Sections:

Asphaltic Concrete Design				
Layer	**Thickness (inches)**			
	Auto Parking Areas (TI=5.0 assumed)[3]	**Auto Road (TI=5.5 assumed)**[3]	**Truck Parking Areas (TI=6.0 assumed)**[3]	**Truck Ramps and Roads (TI=8.0 assumed)**[3]
AC [1, 2]	3.0	3.5	3.5	5.0
Aggregate Base [1]	10.0	11.0	13.0	17.5

1. All materials should meet the current Caltrans Highway Design Manual specifications
   - Asphaltic Base – Caltrans Class 2 aggregate base
2. A minimum 1.5-inch surface course should be used on ACC pavements.
3. The traffic index (TI) is a measure of traffic wheel loading frequency and intensity of anticipated traffic.

The follow table provides options for AC pavement sections reinforced with geogrid. The sections were calculated using the Tensar SpectraPave4PRO-California software. The geogrid material shall be Tensar TriAx TX5 or an equivalent conforming to the physical properties in the 2015 Greenbook Standard Specifications, Multi-Axial Geogrid Table 213-5.2 (E) Type R2. The geogrid shall be placed directly on the subgrade below the aggregate base layer. Adjacent rolls of geogrid shall be overlapped a minimum of 1 foot. Soft subgrade conditions may require up to 3 feet of overlap at the discretion of the geotechnical engineer. The development of wrinkles in the geogrid shall be avoided. A minimum loose fill thickness of 6 inches is required prior to operation of tracked vehicles over the geogrid. When underlying substrate is trafficable with minimal rutting, rubber tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph).

Reinforced pavement design procedures developed by grid producers rely on product specific field and laboratory research. In some cases, this research has tested pavement sections within a limited range of subgrade conditions and pavement thicknesses. Extrapolations are typically used for thicker pavement sections outside those parameters based on computer modeling. These methods represent the state of the practice but have not always been specifically verified by performance testing.

Asphaltic Concrete Design with Geogrid Reinforcement				
Layer	Thickness (inches)			
	Auto Parking Areas (TI=5.0 assumed)[3]	Auto Road (TI=5.5 assumed)[3]	Truck Parking Areas (TI=6.0 assumed)[3]	Truck Ramps and Roads (TI=8.0 assumed)[3]
AC [1, 2]	3.0	3.5	3.5	5.0
Aggregate Base [1]	5.0	6.0	8.0	11.0

1. All materials should meet the current Caltrans Highway Design Manual specifications
   - Asphaltic Base – Caltrans Class 2 aggregate base
2. A minimum 1.5-inch surface course should be used on ACC pavements.
3. The traffic index (TI) is a measure of traffic wheel loading frequency and intensity of anticipated traffic.

The follow table provides options for AC pavement sections supported by chemically treated soil. Chemical treatment involves treating the pavement subgrade soils with a certain percentage of high calcium quicklime and/or cement, usually 3.5 to 5 percent based on the dry unit weight of the soil, for a depth of 12 inches. For estimating purposes, we recommend using 2.25 percent lime, 2.25 percent cement, and a soil unit weight of 110 pounds per cubic foot. For a 12-inch treatment depth, this results in an estimated minimum spread rate of 2.5 pounds per square foot lime and 2.5 pounds per square foot cement. The actual amount of lime/cement to be used should be determined by Terracon and by laboratory testing **at least two weeks prior** to the start of grading operations. Chemical treatment is performed after rough grading of the pavement areas is completed.

Chemically Treated Subgrade Asphaltic Concrete Design				
Layer	**Thickness (inches)**			
	Auto Parking Areas (TI=5.0 assumed)[3]	**Auto Road (TI=5.5 assumed)**[3]	**Truck Parking Areas (TI=6.0 assumed)**[3]	**Truck Ramps and Roads (TI=8.0 assumed)**[3]
AC [1, 2]	3.0	3.5	3.5	5.0
Aggregate Base [1]	4.0	4.0	4.0	7.0
Chemically Treated Subgrade[1,4]	12.0	12.0	12.0	12.0

1. All materials should meet the current Caltrans Highway Design Manual specifications
   - Asphaltic Base – Caltrans Class 2 aggregate base
   - Lime/Cement Treat Materials
2. A minimum 1.5-inch surface course should be used on ACC pavements.
3. The traffic index (TI) is a measure of traffic wheel loading frequency and intensity of anticipated traffic.
4. Chemically treated material shall have a minimum unconfined compressive strength of 300 psi.

Rigid PCC pavements will perform better than AC in areas where short-radii turning and braking are expected (i.e. entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to large or sustained loads. We recommend rigid pavement for the dumpster area to include the area where the trucks will pick up the dumpster. An adequate number of longitudinal and transverse control joints should be placed in the rigid pavement in accordance with ACI and/or AASHTO requirements. Expansion (isolation) joints must be full depth and should only be used to isolate fixed objects abutting or within the paved area.

All concrete for rigid pavements should have a minimum flexural strength of 550 psi, a minimum compressive strength of 4,500 psi. and be placed with a maximum slump of four inches. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

We recommend all PCC pavement details for joint spacing, joint reinforcement, and joint sealing be prepared in accordance with American Concrete Institute (ACI 330R and ACI 325R.9). PCC pavements should be provided with mechanically reinforced joints (doweled or keyed) in accordance with ACI 330R. Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its “green” state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Thickened edges should be used along outside edges of concrete pavements. Edge thickness should be at least 2 inches thicker than concrete pavement thickness and taper to the actual concrete pavement thickness 36 inches inward from the edge. Integral curbs may be used in lieu of thickened edges.

Portland Cement Concrete Design			
Layer	Thickness (inches)		
	Car Parking and Access Lanes [1]	Truck Parking [1]	Dumpster Pads [1,3]
PCC [2]	5.0	6.5	7.5
Aggregate base [2]	4.0	4.0	4.0

1. Car Parking and Access Lanes: ADTT = 1 truck per day
   Truck Parking: ADTT = 25 trucks per day
   Dumpster Pads: Per Category C
2. All materials should meet the current Caltrans Highway Design Manual specifications.
3. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

<u>As more specific traffic information becomes available for the project, we should be contacted to reevaluate the pavement calculations.</u>

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

The pavement surfacing and adjacent sidewalks should be sloped to provide rapid drainage of surface water. Water should not be allowed to pond on or adjacent to these grade-supported slabs, since this could saturate the subgrade and contribute to premature pavement or slab deterioration. In areas where pavement sections abut bioswales, curb should extend below the planned AB section to intercept water infiltration below the pavement section. Water migration in and out of the pavement sections may result in repeated shrinkage and swelling and increasing pavement section fatigue.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g. crack and joint sealing and patching) and global maintenance (e.g. surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

SWIMMING POOL

We understand the proposed development may include an at-grade swimming pool. The proposed pool may consist of a conventional pool shell bearing into firm native soil. If the pool shell shotcrete will not be placed against a vertical cut consisting of firm native soil, the pool walls should be designed for both retaining and free-standing conditions. The pool excavation operations should be observed by an engineer/geologist from Terracon to verify that suitable depth and bearing material have been encountered. Expansive soils within the pool excavation should be maintained in an elevated moisture content during construction.

Pool walls should be designed to resist a lateral earth pressure of 65 pounds per cubic foot (pcf) equivalent fluid pressure for walls with flat backfill. Free standing walls should be designed to resist and outward fluid pressure of 63 pcf. These pressures do not account for additional surcharges adjacent to the pool shell.

It is our understanding no raised bond beams will be utilized for pool construction.

Additional geotechnical design considerations for the swimming pool and items that may affect the future geotechnical stability of the pool system are listed below.

- **Isolate pool shell** – The proposed pool should be isolated from any source that could cause additional settlement of the pool. Foundations from both buildings and other structures related to the pool should be kept a minimum distance equal to the depth of the pool from the pool's edge to reduce the effect of the foundation on the pool shell. Additionally, pool decks should not be tied into the pool shell.

- **Groundwater concerns** – The presence of groundwater could cause the pool shell to float if the pool is emptied. Groundwater was encountered in our borings/CPTs at the time of our field exploration at depths varying from 13 to 18 feet bgs. However, careful observation of groundwater should be performed before and after pool construction to identify if groundwater is present in the excavation for the pool shell. If groundwater or seepage is observed in the pool excavation, the pool should be underlain by a 6-inch thick layer of 3/4-inch clean gravel underlain by Mirafi 140N filter fabric or Caltrans Class II permeable material. A 4-inch diameter perforated Schedule 40 PVC or ABS pipe should be installed in the gravel at the deepest point. The perforated pipe should slope at a 2 percent minimum grade to a tight line at the edge of the pool that carries the drainage to an existing drainage system, a positive gravity outlet, or to an observation well where water can be removed by a submersible pump. In addition, a hydrostatic pressure relief system should be installed in the deep end of the pool.

- **Avoid surcharge loading on pool shell** – The addition of surcharge loads on the pool shell either during construction or after construction should be avoided to limit the possibility of damaging the pool walls.

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.

Corrosivity Test Results Summary						
Boring	**Sample Depth (feet)**	**Soil Description**	**Soluble Sulfate (ppm)**	**Soluble Chloride (ppm)**	**Electrical Resistivity (Ω-cm)**	**pH**
B1	1-2.5	CL	421	100	1164	8.74

These test results are provided to assist in determining the type and degree of corrosion protection that may be required for the project. We recommend that a certified corrosion engineer determine the need for corrosion protection and design appropriate protective measures.

Resistivity

The resistivity value indicates the sample tested exhibits a high corrosive potential to buried metal pipes.

Evaluation of the test results is based upon the guidelines of J.F. Palmer, "Soil Resistivity Measurements and Analysis", Materials Performance, Volume 13, January 1974. The following table outlines the guidelines for soil resistivity for corrosion potential.

Corrosion Potential of Soil on Steel	
Soil Resistivity (ohm-cm)	**Corrosion Potential**
0 to 1,000	Very High
1,000 to 2,000	High
2,000 to 5,000	Moderate
> 5,000	Mild

Sulfates

Results of soluble sulfate testing indicates the samples of the on-site soil tested poses a moderate exposure to sulfate when classified in accordance with Table 19.3.1.1 of section 19.3.1 of the ACI 318-14 Design Manual. Concrete should be designed in accordance with the provisions of Exposure Class S1 as designated by the ACI 318-14 Design Manual, Section 19.3.

Laboratory pH

Data suggests the soil pH should not be the dominant soil variable affecting soil corrosion if the soil has a pH in the 5 to 8 range. The pH of the sample tested was above the recommended range, and should therefore be considered when determining soil corrosion potential.

GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

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. Natural 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 the final 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 or collaboration through this system 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 impact 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. 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. This report should not be considered valid and used after 3 years without written permission from Terracon.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings/CPTs	Boring/CPT Depth (feet)	Planned Location
2	5	Planned parking/driveway area
2	26½	Planned building area
2 CPT[1]	39 to 50½	Planned building area

1. Cone penetrometer test

Boring/CPT Layout and Elevations: The boring/CPT layout was performed by Terracon. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±20 feet). If a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted drill rig using continuous flight, solid stem augers. One to three samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using split-barrel sampling. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon is 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. The values provided on our boring logs are uncorrected. Additionally, we observed and recorded groundwater levels during drilling and sampling. Per the requirements of the local health department and for safety purposes, all borings were backfilled with grout after their completion. Pavements were patched with cold-mix asphalt.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to a Terracon 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 include visual classifications of the materials encountered 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.

For the cone penetrometer testing, the CPT hydraulically pushes an instrumented cone through the soil while nearly continuous readings are recorded to a portable computer. The cone is equipped with electronic load cells to measure tip resistance and sleeve resistance and a pressure transducer to measure the generated ambient pore pressure. The face of the cone has an apex angle of 60° and an area of 10 cm^2. Digital Data representing the tip resistance, friction resistance, pore water pressure, and probe inclination angle are recorded about every 2 centimeters while advancing through the ground at a rate between 1½ and 2½ centimeters per second. These measurements are correlated to various soil properties used for geotechnical design. No soil samples are gathered through this subsurface investigation technique. CPT testing was conducted in general accordance with ASTM D5778 "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils."

Laboratory Testing

The project engineer reviewed the field data and assigned various laboratory tests to better understand the engineering properties of the various soil strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
- ASTM G162 – 99 Standard Practice for Conducting and Evaluating Laboratory Corrosion Tests in Soils

The laboratory testing program often includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we describe and classify the soil samples in accordance with the Unified Soil Classification System.

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION and NEARBY GEOTECHNICAL DATA

Cambria Hotel ■ Pleasant Hill, Contra Costa, California

July 6, 2018 ■ Terracon Project No. ND185084

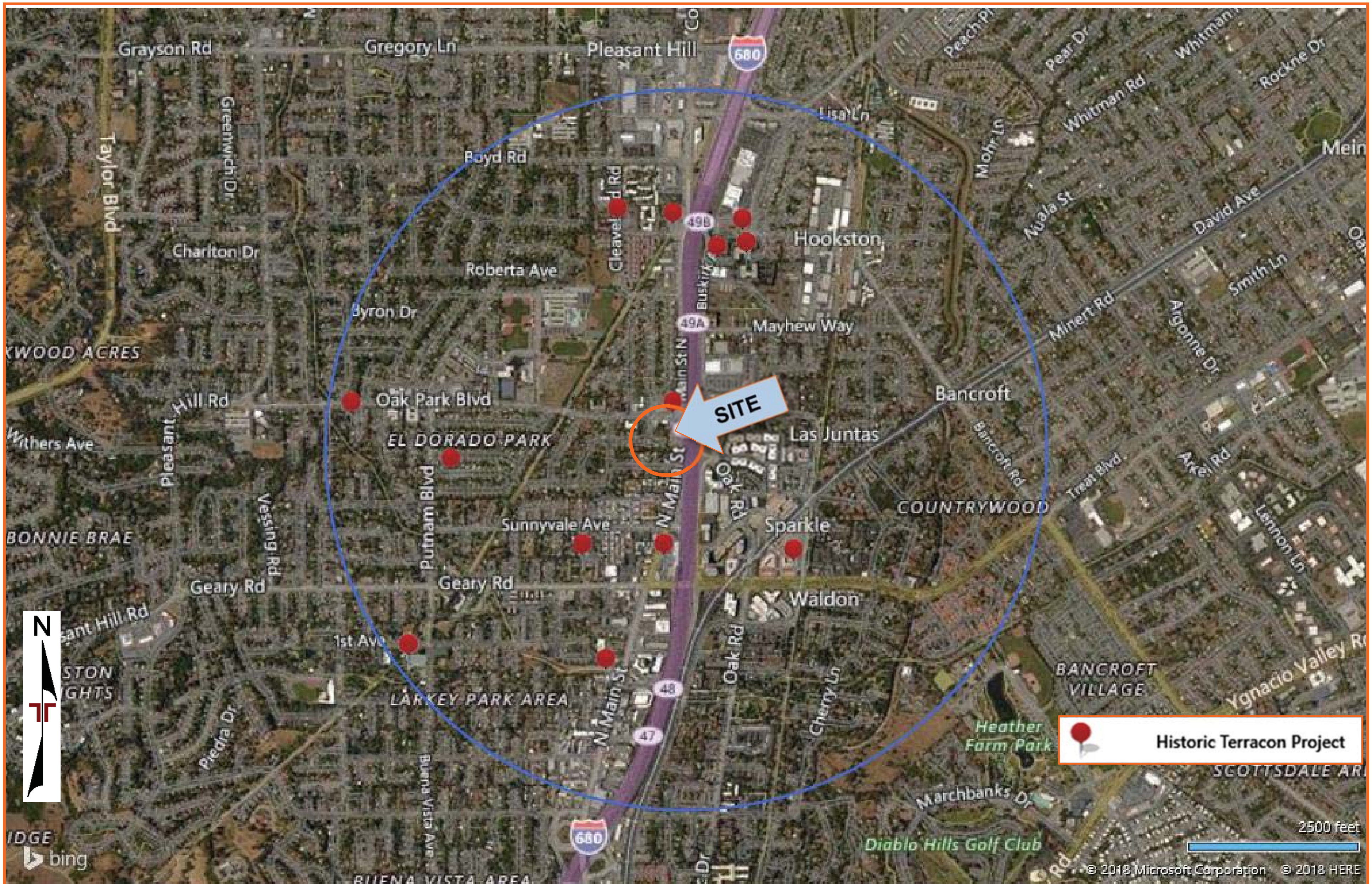


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Cambria Hotel ■ Pleasant Hill, Contra Costa, California
July 6, 2018 ■ Terracon Project No. ND185084

Terracon GeoReport

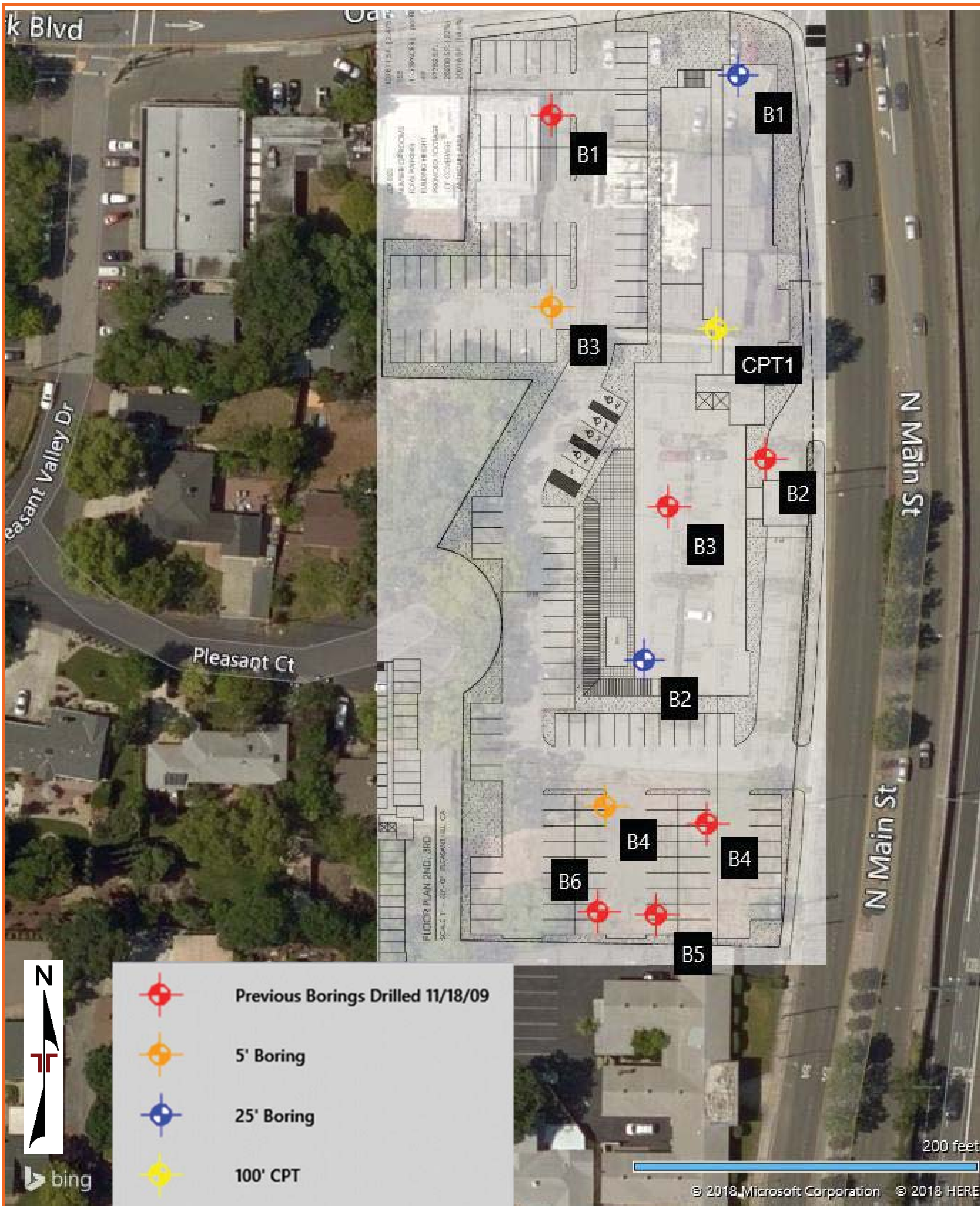


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B1

PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

SITE: 3131 N. Main Street
Pleasant Hill, CA

LOCATION See Exploration Plan

Latitude: 37.9331° Longitude: -122.061°

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (tsf)	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	**WELL GRADED SAND WITH GRAVEL (SW)**, fine to coarse grained, brown with reddish brown, loose to medium dense										
3.5	**LEAN CLAY WITH SAND (CL)**, fine to medium grained, dark brown, stiff				4-6-10		1.5 (HP)	21	93	45-17-28	74
13.5	**POORLY GRADED SAND (SP)**, fine to medium grained, brown, very loose to loose	5			6-7-6			21			
					2-3-6			22	99		
		10			3-3-3			21	93		
			▽								
26.5	**SILTY CLAY (CL-ML)**, fine to medium grained, brown, stiff	15			3-5-5			35	80		
		20			7-6-10 N=16			31			
		25			6-7-10 N=17						
	Boring Terminated at 26.5 Feet										

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

Hammer Type: Rope and Cathead

Advancement Method:
4" Solid Stem Auger

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

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:
AC: 2", AB: 4.5"

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
5075 Commercial Cir, Ste E
Concord, CA

Boring Started: 06-20-2016	Boring Completed: 06-20-2016
Drill Rig: B-24	Driller: CG
Project No.: ND185084	

BORING LOG NO. B2

PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

SITE: 3131 N. Main Street
Pleasant Hill, CA

LOCATION See Exploration Plan

Latitude: 37.9322° Longitude: -122.0612°

GRAPHIC LOG DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (tsf)	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY LEAN CLAY (CL), some gravel and silt, fine to medium grained, dark reddish brown, stiff				7-6-7		1.25 (HP)	16			
5.0	**WELL GRADED SAND (SW)**, with silt, fine to medium grained, brown, loose	5			5-5-6			8	84		
6.5	**POORLY GRADED SAND (SP)**, fine grained, brown, loose				4-5-6			24	84		
9.5	**FAT CLAY (CH)**, fine to medium grained, dark brown, stiff to very stiff	10			5-8-13	2.16		26	88	50-17-33	91
14.0	**SANDY SILTY CLAY (CL-ML)**, fine to medium grained, brown, stiff	15			4-5-5	1.38		31	83		
			▽								
19.5	**SILTY CLAY (CL-ML)**, fine to medium grained, brown, stiff	20			4-6-7			29	83		
		25			7-8-9 N=17			22			
26.5	***Boring Terminated at 26.5 Feet***										

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

Hammer Type: Rope and Cathead

Advancement Method:
4" Solid Stem Auger

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

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:
AC: 2", AB: 9"

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
5075 Commercial Cir, Ste E
Concord, CA

Boring Started: 06-20-2016	Boring Completed: 06-20-2016
Drill Rig: B-24	Driller: CG
Project No.: ND185084	

BORING LOG NO. B3

PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

SITE: 3131 N. Main Street
Pleasant Hill, CA

LOCATION See Exploration Plan

Latitude: 37.9328° Longitude: -122.0614°

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (tsf)	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	1.5	**WELL GRADED SAND WITH GRAVEL (SW)**, fine to coarse grained, brown, loose to medium dense										
	5.0	**SANDY LEAN CLAY (CL)**, fine to medium grained, dark brown, stiff	5		X	5-5-9 N=14			22			
		Boring Terminated at 5 Feet										

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

Hammer Type: Rope and Cathead

Advancement Method:
4" Solid Stem Auger

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

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:
AC: 2", AB: 4.5"

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
5075 Commercial Cir, Ste E
Concord, CA

Boring Started: 06-20-2016	Boring Completed: 06-20-2016
Drill Rig: B-24	Driller: CG
Project No.: ND185084	

BORING LOG NO. B4

PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

SITE: 3131 N. Main Street
Pleasant Hill, CA

LOCATION See Exploration Plan

Latitude: 37.932° Longitude: -122.0613°

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (tsf)	LABORATORY HP (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	1.5	**WELL GRADED SAND WITH GRAVEL (SW)**, fine to coarse grained, brown, loose to medium dense										
		SANDY LEAN CLAY (CL), fine to medium grained, dark brown, stiff			X	4-5-10 N=15			7			
	5.0		5									
		Boring Terminated at 5 Feet										

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

Hammer Type: Rope and Cathead

Advancement Method:
4" Solid Stem Auger

Abandonment Method:
Boring backfilled with cement-bentonite grout upon completion.

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

Groundwater not encountered

Terracon
5075 Commercial Cir, Ste E
Concord, CA

Boring Started: 06-20-2016	Boring Completed: 06-20-2016
Drill Rig: B-24	Driller: CG
Project No.: ND185084	

CPT LOG NO. CPT-01

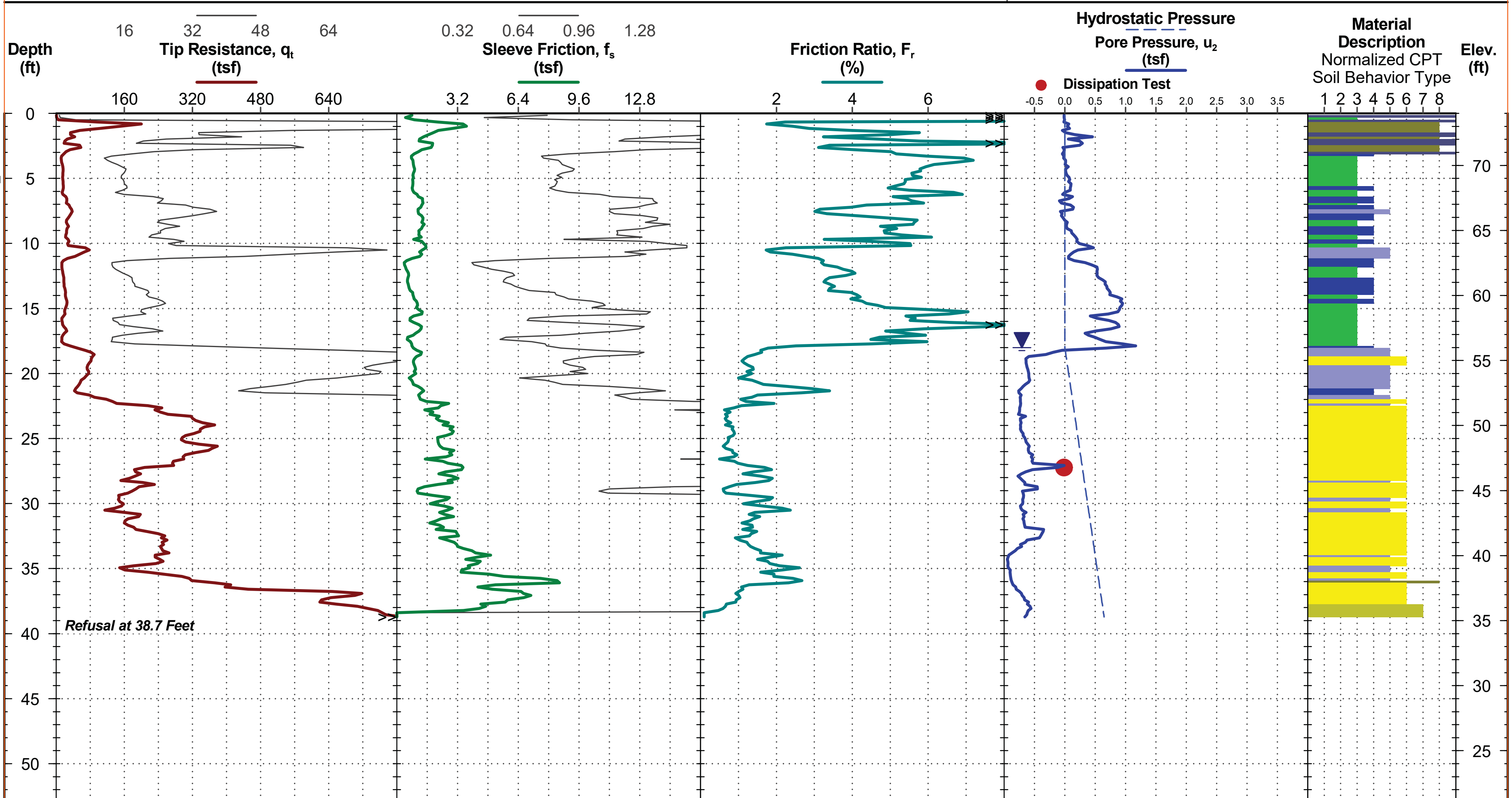
PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

TEST LOCATION: See Exploration Plan

SITE: 3131 N. Main Street
Pleasant Hill, CA

Surface Elev.: 74 ft
Latitude: 37.9325°
Longitude: -122.06107°



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

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

18 ft estimated water depth
(used in normalizations and correlations; See Supporting Information)

Probe no. DDG1418

Terracon
5075 Commercial Cir, Ste E
Concord, CA

CPT Started: 6/21/2018	CPT Completed: 6/21/2018
Rig: CPT	Operator: RB-JM
Project No.: ND185084	

CPT LOG NO. CPT-02

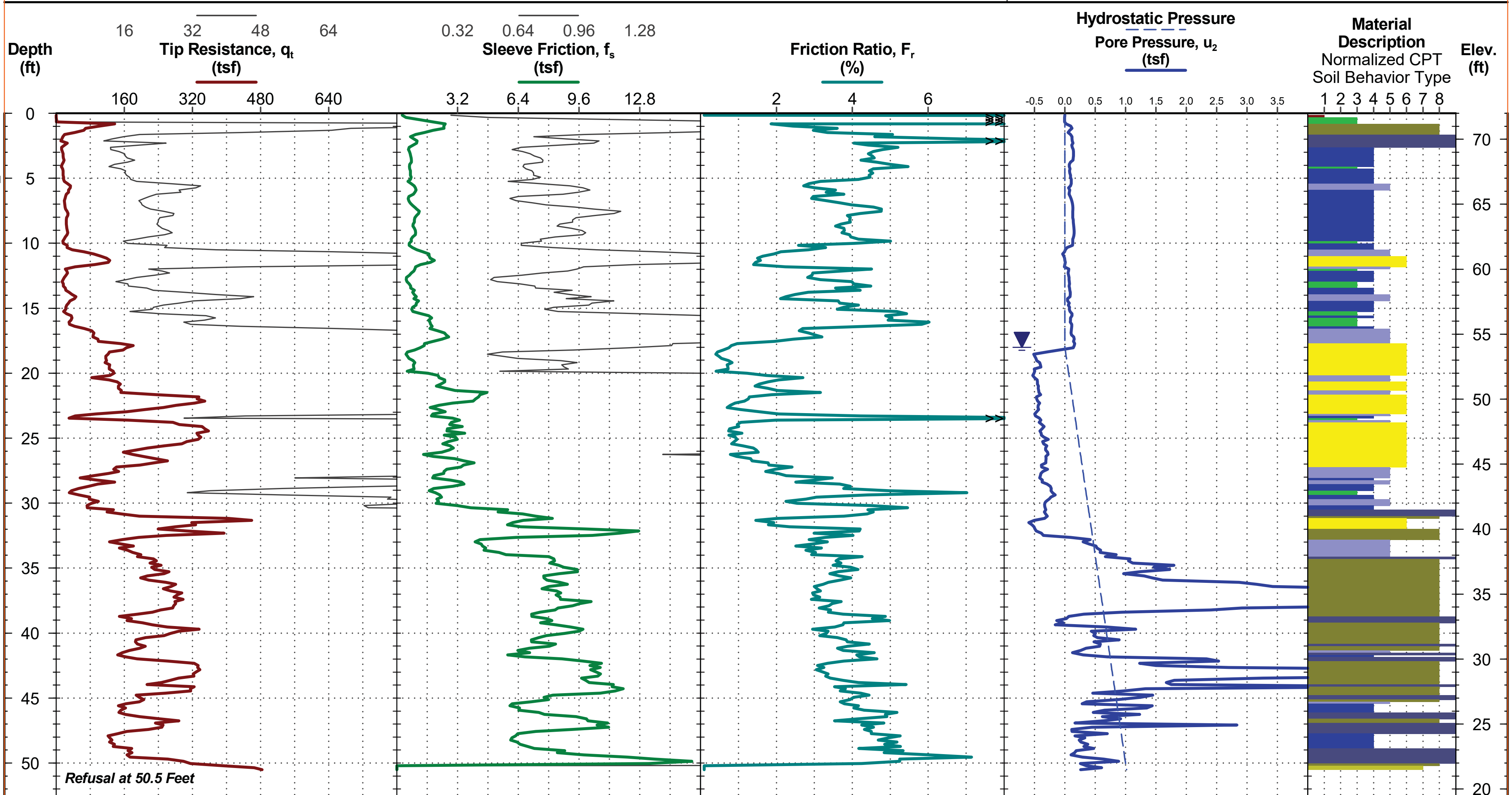
PROJECT: Cambria Hotel

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

TEST LOCATION: See Exploration Plan

SITE: 3131 N. Main Street
Pleasant Hill, CA

Surface Elev.: 72 ft
Latitude: 37.93307°
Longitude: -122.06124°



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

Dead weight of rig used as reaction force.
CPT sensor calibration reports available upon request.

1 Sensitive, fine grained
2 Organic soils - clay
3 Clay - silty clay to clay
4 Silt mixtures - clayey silt to silty clay
5 Sand mixtures - silty sand to sandy silt
6 Sands - clean sand to silty sand
7 Gravelly sand to dense sand
8 Very stiff sand to clayey sand
9 Very stiff fine grained

WATER LEVEL OBSERVATION

18 ft estimated water depth
(used in normalizations and correlations;
See **Supporting Information**)

Probe no. DDG1418

Terracon
5075 Commercial Cir, Ste E
Concord, CA

CPT Started: 6/21/2018
CPT Completed: 6/21/2018
Rig: CPT
Operator: RB-JM
Project No.: ND185084

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER
B1

PROJECT NUMBER: **WGE090523**
DATE DRILLED: **11/19/09**
PROJECT NAME: **IN-N-OUT - PLEASANT HILL**
GROUND SURFACE ELEVATION: **0.0** Feet
LOCATION: **SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA**
DRILLING EQUIP.: **TRUCK MOUNTED MOBILE CME 75**

PLATE NO. B1

Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Soil Lithology Description	Notes
				ASPHALT: 3 in., asphalt	
				AGGREGATE BASE: 8 in., aggregate base, dense, moist, brown	
				SANDY CLAY: (CL) Clay, sandy, stiff, moist, dark brown	
GS					R-Value = 5
				SAND: (SP) Sand, with silt and gravel, medium dense, moist, brown	
CM	17	110	10		
				CLAYEY SAND: (SC) Sand, clayey, medium dense, moist to saturated, brown	
CM	21	106	10		
				SAND: (SP) Sand, with silt, medium dense, saturated, brown	
CM	20	111	19		
					Boring terminated at 16.5 feet

Depth, ft.: 0, -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER

B2

PROJECT NUMBER: **WGE090523**
DATE DRILLED: **11/18/09**
PROJECT NAME: **IN-N-OUT - PLEASANT HILL**
GROUND SURFACE ELEVATION: **0.0** Feet
LOCATION: **SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA**
DRILLING EQUIP.: **TRUCK MOUNTED MOBILE B24**

PLATE NO. B2

Depth, ft.	Sample	Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Blow Count Histogram	Ground Water	Soil Lithology	Soil Lithology Description	Notes
0									ASPHALT: 6 in., asphalt	
-1									AGGREGATE BASE: 3 in., aggregate base, dense, moist, brown/gray	
-2									SANDY CLAY: (CL) Clay, sandy, stiff to very stiff, moist, dark brown	
-3		GS								
-4										
-5										
-6		CM	26		17					pp = 2.0 tsf
-7									SANDY CLAY: (CL) Clay, sandy, very stiff, moist, gray/brown	
-8										
-9										
-10										
-11		CM	26	94	15					pp = 3.0 tsf
-12										Boring terminated at 11.5 feet
-13										
-14										
-15										
-16										
-17										
-18										
-19										
-20										

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER

B3

PROJECT NUMBER: **WGE090523**
DATE DRILLED: **11/18/09**
PROJECT NAME: **IN-N-OUT - PLEASANT HILL**
GROUND SURFACE ELEVATION: **0.0** Feet
LOCATION: **SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA**
DRILLING EQUIP.: **TRUCK MOUNTED MOBILE B24**

PLATE NO. B3

Depth, ft.	Sample	Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Blow Count Histogram	Ground Water	Soil Lithology	Soil Lithology Description	Notes
0									ASPHALT: 4 in., asphalt	
-1									AGGREGATE BASE: 8 in., aggregate base, dense, moist, brown	
-2									SANDY CLAY: (CL) Clay, sandy, stiff to very stiff, moist, dark brown	
-3										
-4		CM	25	96	16					pp = 2.75 tsf
-5										
-6									CLAYEY SAND: (SC) Sand, clayey, loose to medium dense, moist, brown	
-7										
-8										
-9		CM	18	103	13					
-10										
-11										
-12										
-13										
-14		CM	21	105	9					
-15										Boring terminated at 15 feet
-16										
-17										
-18										
-19										
-20										

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER

B4

PROJECT NUMBER: **WGE090523**
DATE DRILLED: **11/19/09**
PROJECT NAME: **IN-N-OUT - PLEASANT HILL**
GROUND SURFACE ELEVATION: **0.0** Feet
LOCATION: **SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA**
DRILLING EQUIP.: **TRUCK MOUNTED MOBILE CME 75**

PLATE NO. B4

Depth, ft.	Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Ground Water	Soil Lithology Description	Notes
0 to -4.5	GS					SANDY CLAY: (CL) Clay, sandy, stiff, moist, dark brown	EI = 37
-4.5 to -18.5 (sample at -6)	CM	18	104	13		CLAYEY SAND: (SC) Sand, clayey, with interbedded sand layers, loose to medium dense, moist to saturated, brown	pi (ll = 34, pi = 15) -200 = 45%
-10					▼		
-11	CM	27		5			
-16	CM	31	92	11			
-18.5 to -21.5 (sample at -21)	CM	28	92	11		SANDY CLAY: (CL) Clay, sandy, stiff, saturated, dark brown/brown	pp = 1.25 tsf
-21.5 to -30 (sample at -26)	CM	28	105	34		SAND: (SP) Sand, with silt, dense, saturated, brown	-200 = 21%
-30 to -35 (sample at -31)	CM	9	133	42		GRAVELLY SAND: (SP) Sand, gravelly, with some silt, dense, saturated, brown	-200 = 6%
-35 to -40 (sample at -36)	CM	30	93	16		CLAYEY SAND: (SC) Sand, clayey, medium dense, saturated, brown	-200 = 40%
-40 to -41.5 (sample at -41)	CM	20	116	39		SAND: (SP) Sand, with clay, dense, saturated, blue/gray	-200 = 27% Boring terminated at 41.5 feet

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER

B5

PROJECT NUMBER: WGE090523
DATE DRILLED: 11/18/09
PROJECT NAME: IN-N-OUT - PLEASANT HILL
GROUND SURFACE ELEVATION: 0.0 Feet
LOCATION: SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA
DRILLING EQUIP.: TRUCK MOUNTED MOBILE B24

PLATE NO. B5

Depth, ft.	Sample	Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Notes
-1 to -2.5	Sample	CM	21	91	13	pi (ll = 46, pi = 25) -200 = 69% pp = 2.5 tsf
-5 to -6.5	Sample	CM	18	98	40	
-10 to -11.5	Sample	CM	25	97	12	gravelly sand w/ silt layer
-15 to -16.5	Sample	CM	32		12	pp = 2.25 tsf

Depth, ft.	Soil Lithology Description
0 to -4	SANDY CLAY: (CL) Clay, sandy, stiff, moist, dark brown
-4 to -10	CLAYEY SAND: (SC) Sand, clayey, with interbedded sand layers, medium dense, moist, brown
-10 to -16.5	SANDY CLAY: (CL) Clay, sandy, stiff, saturated, brown

Ground Water: -10 ft.

Boring terminated at 16.5 feet

Neil O. Anderson & Assoc., Inc.
1190 Burnett Ave, Suite A, Concord, CA 94520
(925)609-7224 Fax (925)609-6324

LOG OF TEST BORING

BOREHOLE NUMBER
B6

PROJECT NUMBER: **WGE090523**
DATE DRILLED: **11/19/09**
PROJECT NAME: **IN-N-OUT - PLEASANT HILL**
GROUND SURFACE ELEVATION: **0.0** Feet
LOCATION: **SWC NORTH MAIN STREET AND OAK PARK BOULEVARD, PLEASANT HILL, CA**
DRILLING EQUIP.: **TRUCK MOUNTED MOBILE CME 75**

PLATE NO. B6

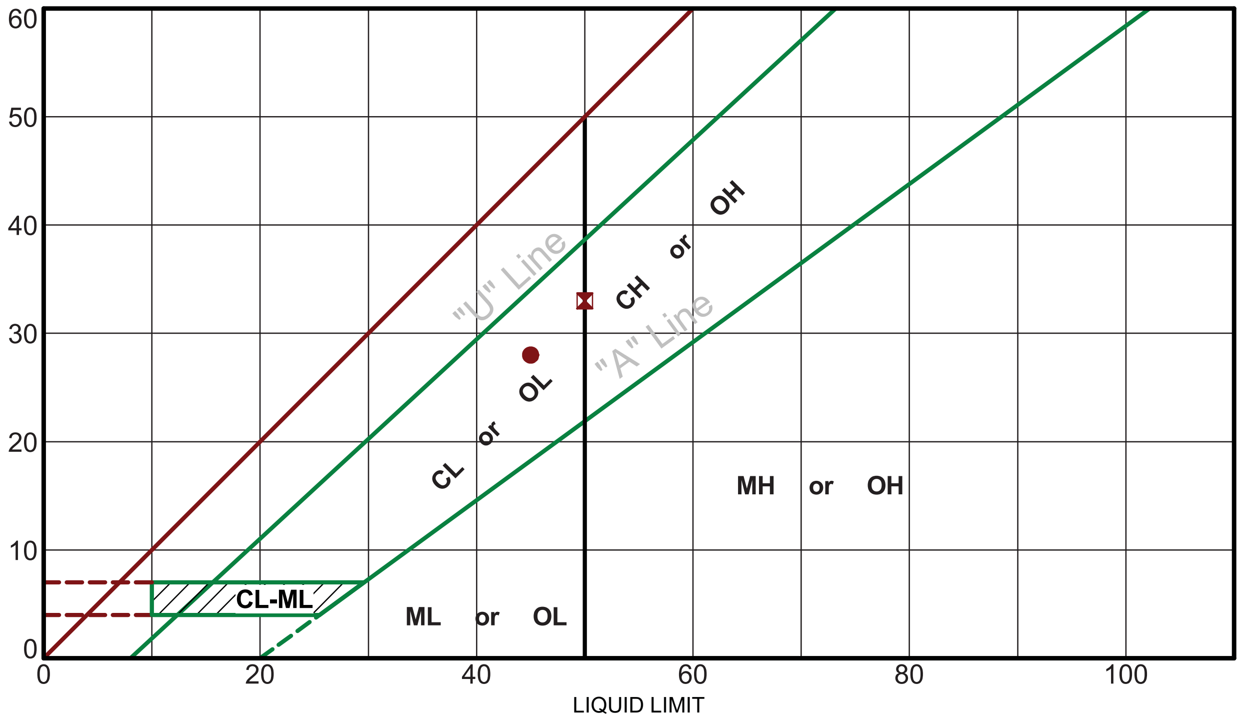
Depth, ft.	Sampling Method	Moisture, %	Dry Density, pcf	Blow Counts	Soil Lithology Description	Notes
0 to -3.5	GS (-2)				SANDY CLAY: (CL) Clay, sandy, stiff, moist, dark brown	Max. Dry Density = 113.2 pcf Opt. Water Content = 13.0%
-3.5 to -11	CM (-5)	16	103	12	SAND: (SP) Sand, trace of silt, medium dense, moist to saturated, brown	pH = 6.93 Min. Resistivity = 1,470 ohm-cm Chloride = 14.6 ppm Sulfate = 18.5 ppm
	CM (-10)	14	115	10		
-11 to -15.5	CM (-15)	30	119	12	SANDY CLAY: (CL) Clay, sandy, stiff, saturated, brown	
-15.5						Boring terminated at 15.5 feet

Depth scale: 0, -1, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -20

Column headings: Depth, ft. | Sample | Sampling Method | Moisture, % | Dry Density, pcf | Blow Counts | Blow Count Histogram | Ground Water | Soil Lithology | Soil Lithology Description | Notes

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B1	1 - 2.5	45	17	28	74	CL	LEAN CLAY with SAND
⊠	B2	10 - 11.5	50	17	33	91	CH	FAT CLAY

PROJECT: Cambria Hotel

SITE: 3131 N. Main Street
Pleasant Hill, CA

Terracon
5075 Commercial Cir Ste E
Concord, CA

PROJECT NUMBER: ND185084

CLIENT: Stratus Development Partners, LLC
Newport Beach, CA

CHEMICAL LABORATORY TEST REPORT

Project Number: ND185084
Service Date: 06/27/18
Report Date: 07/03/18
Task:

750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client

Stratus Development Partners, LLC

Newport Beach, CA

Project

Cambria Hotel

Sample Submitted By: Terracon (ND) **Date Received:** 6/27/2018 **18-0776**

Results of Corrosion Analysis

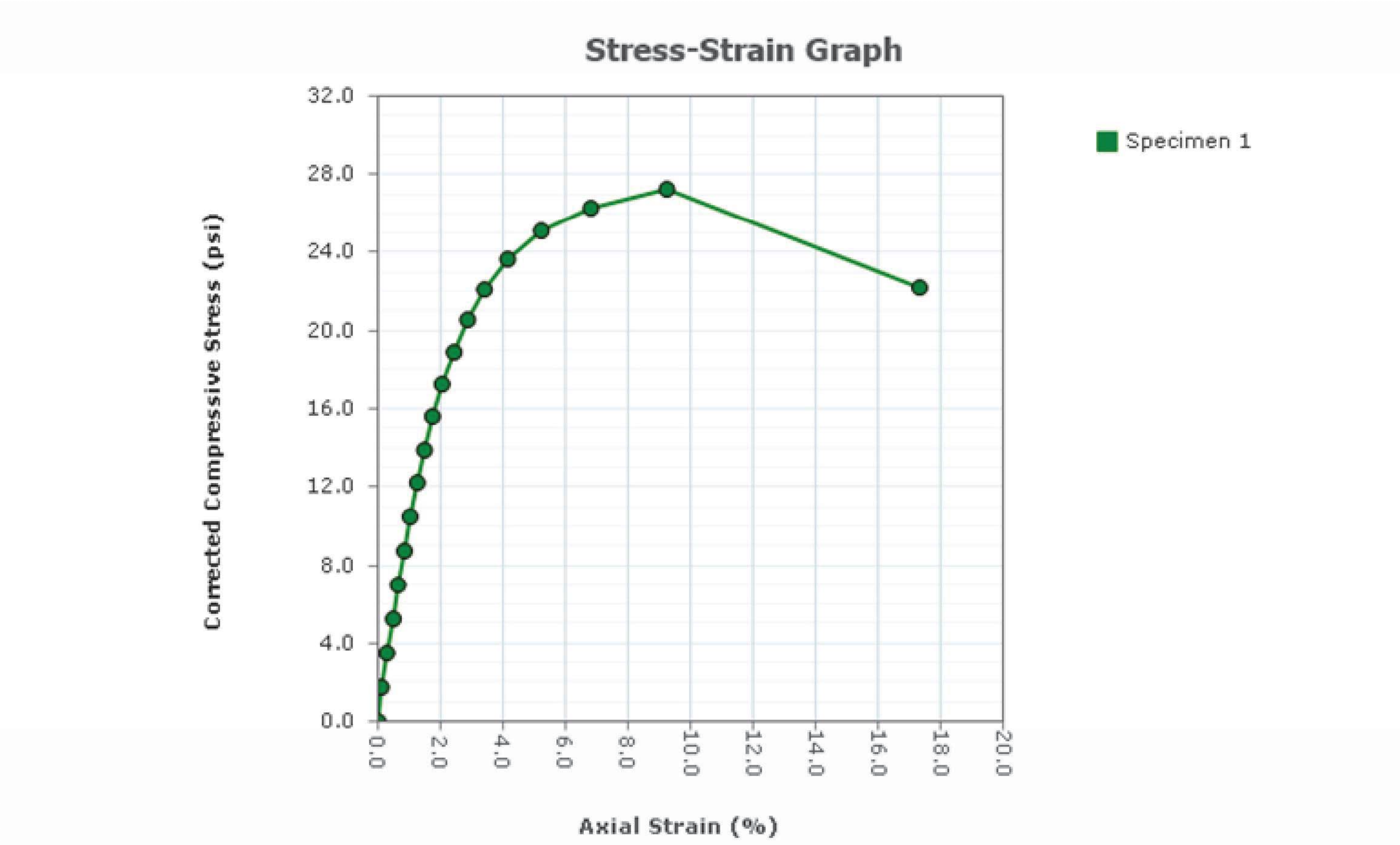
Sample Number	B1-1
Sample Location	B-1
Sample Depth (ft.)	1.0-2.5
pH Analysis, AWWA 4500 H	8.74
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	421
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	100
Red-Ox, AWWA 2580, (mV)	+722
Total Salts, AWWA 2540, (mg/kg)	835
Resistivity, ASTM G 57, (ohm-cm)	1164

Analyzed By: N. Campo

Nathan Campo
Engineering Technician I

Unconfined Compression Test

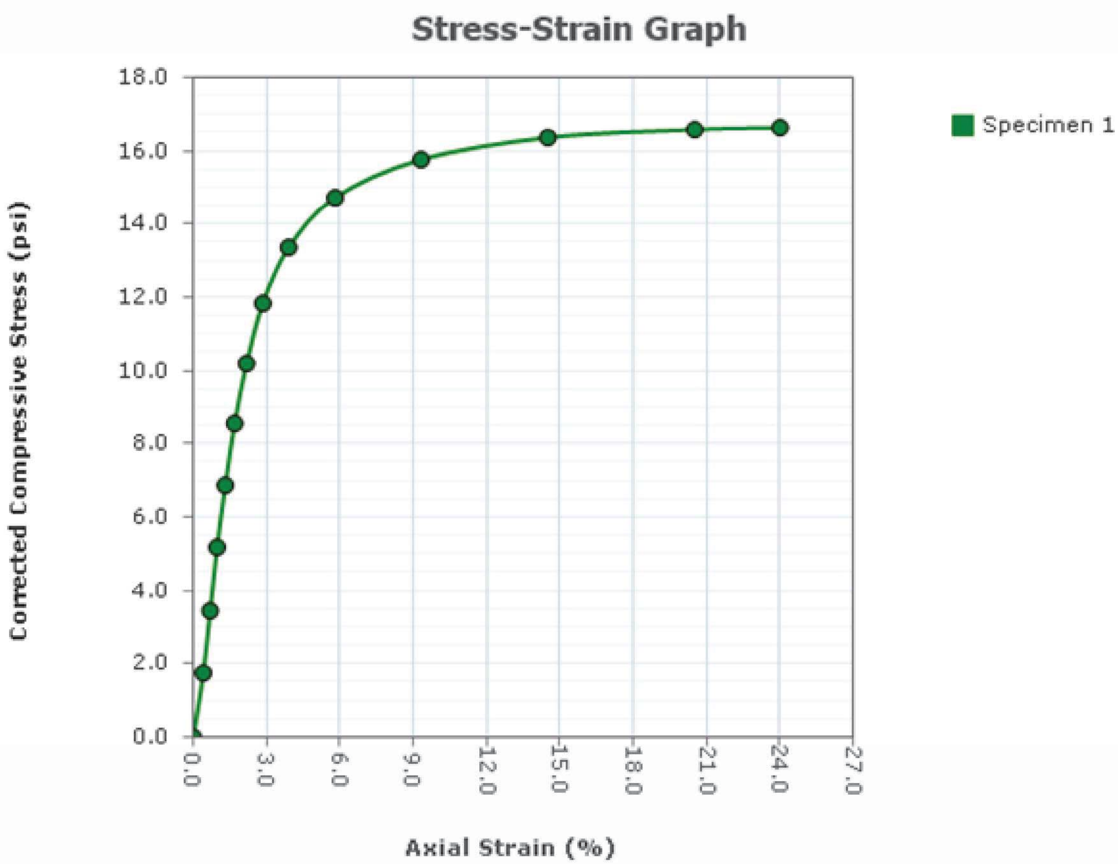
ASTM D2166



Project:	Cambria Hotel
Project Number:	ND185084
Sampling Date:	1/25/2018
Sample Number:	4
Sample Depth:	10-11.5
Boring Number:	2
Location:	
Client Name:	Stratus Development Partners, LLC - Newport Beach, CA
Remarks:	

Unconfined Compression Test

ASTM D2166



Project:	Cambria Hotel
Project Number:	ND185084
Sampling Date:	6/25/2018
Sample Number:	5
Sample Depth:	15-16.5
Boring Number:	2
Location:	
Client Name:	Stratus Development Partners, LLC - Newport Beach, CA
Remarks:	

Test Date: 6/28/2018 Checked By: ____________ Date: ____________

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Cambria Hotel ■ Pleasant Hill, Contra Costa, California

July 6, 2018 ■ Terracon Project No. ND185084

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

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

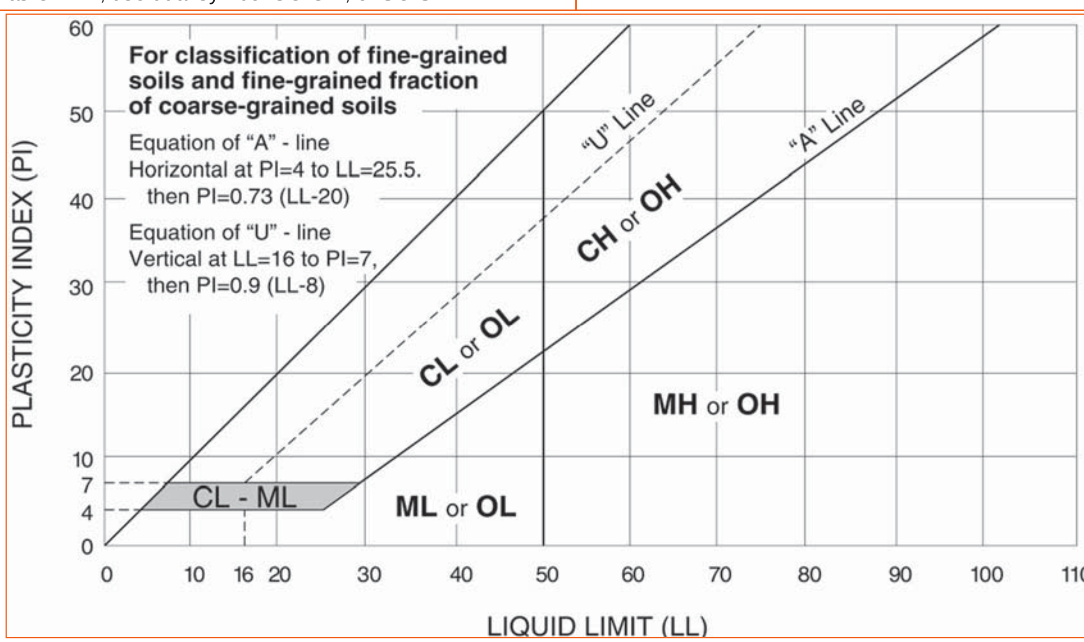
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



CPT GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Cambria Hotel ■ Pleasant Hill, CA

6/29/2018 ■ Terracon Project No. ND185084

DESCRIPTION OF MEASUREMENTS AND CALIBRATIONS

To be reported per ASTM D5778:

Uncorrected Tip Resistance, q_c
Measured force acting on the cone divided by the cone's projected area

Corrected Tip Resistance, q_t
Cone resistance corrected for porewater and net area ratio effects
$q_t = q_c + u_2(1 - a)$
Where a is the net area ratio, a lab calibration of the cone typically between 0.70 and 0.85

Pore Pressure, u
Pore pressure measured during penetration
u_1 - sensor on the face of the cone
u_2 - sensor on the shoulder (more common)

Sleeve Friction, f_s
Frictional force acting on the sleeve divided by its surface area

Normalized Friction Ratio, F_r
The ratio as a percentage of f_s to q_t, accounting for overburden pressure

To be reported per ASTM D7400, if collected:

Shear Wave Velocity, V_s
Measured in a Seismic CPT and provides direct measure of soil stiffness

DESCRIPTION OF GEOTECHNICAL CORRELATION

Normalized Tip Resistance, Q_{tn}
$Q_{tn} = ((q_t - \sigma_{V0})/P_a)(P_a/\sigma'_{V0})^n$
$n = 0.381(I_c) + 0.05(\sigma'_{V0}/P_a) - 0.15$

Over Consolidation Ratio, OCR
$OCR\ (1) = 0.25(Q_{tn})^{1.25}$
$OCR\ (2) = 0.33(Q_{tn})$

Undrained Shear Strength, S_u
$S_u = Q_{tn} \times \sigma'_{V0}/N_{kt}$
N_{kt} is a soil-specific factor (shown on S_u plot)

Sensitivity, S_t
$S_t = (q_t - \sigma_{V0}/N_{kt}) \times (1/f_s)$

Effective Friction Angle, ϕ'
$\phi'\ (1) = \tan^{-1}(0.373[\log(q_t/\sigma'_{V0}) + 0.29])$
$\phi'\ (2) = 17.6 + 11[\log(Q_{tn})]$

Unit Weight, γ
$\gamma = (0.27[\log(F_r)]+0.36[\log(q_t/atm)]+1.236) \times \gamma_{water}$
σ_{V0} is taken as the incremental sum of the unit weights

Small Strain Shear Modulus, G_0
$G_0\ (1) = \rho V_s^2$
$G_0\ (2) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{V0})$

Soil Behavior Type Index, I_c
$I_c = [(3.47 - \log(Q_{tn})^2 + (\log(F_r) + 1.22)^2]^{0.5}$

SPT N_{60}
$N_{60} = (q_t/atm) / 10^{(1.1268 - 0.2817Ic)}$

Elastic Modulus, E_s (assumes $q/q_{ultimate}$ ~ 0.3, i.e. FS = 3)
$E_s\ (1) = 2.6\psi G_0$ where $\psi = 0.56 - 0.33\log Q_{tn,clean\ sand}$
$E_s\ (2) = G_0$
$E_s\ (3) = 0.015 \times 10^{(0.55Ic + 1.68)}(q_t - \sigma_{V0})$
$E_s\ (4) = 2.5q_t$

Constrained Modulus, M
$M = \alpha_M(q_t - \sigma_{V0})$
For $I_c > 2.2$ (fine-grained soils)
$\alpha_M = Q_{tn}$ with maximum of 14
For $I_c < 2.2$ (coarse-grained soils)
$\alpha_M = 0.0188 \times 10^{(0.55Ic + 1.68)}$

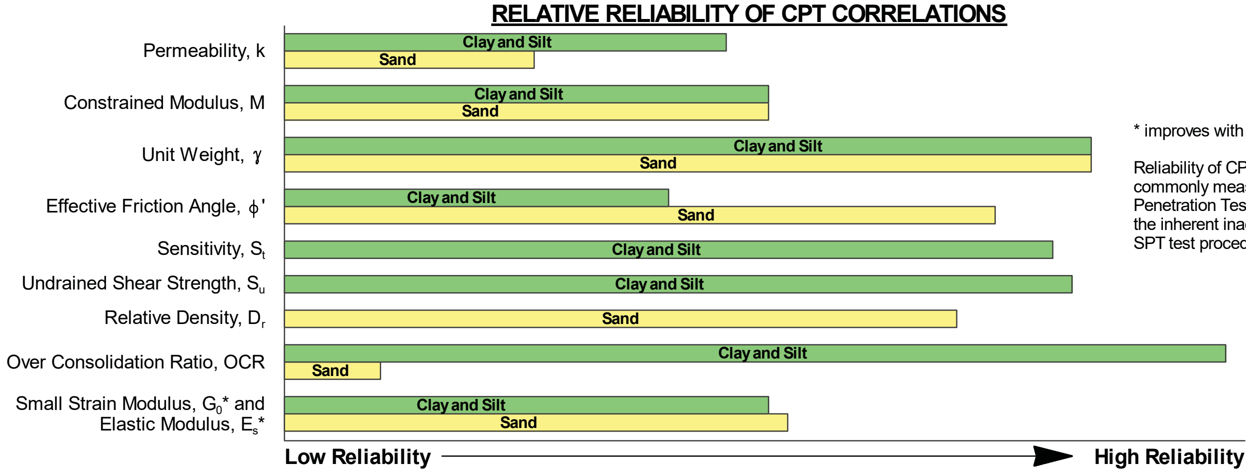
Hydraulic Conductivity, k
For $1.0 < I_c < 3.27$ $k = 10^{(0.952 - 3.04Ic)}$
For $3.27 < I_c < 4.0$ $k = 10^{(-4.52 - 1.37Ic)}$

Relative Density, D_r
$D_r = (Q_{tn} / 350)^{0.5} \times 100$

REPORTED PARAMETERS

CPT logs as provided, at a minimum, report the data as required by ASTM D5778 and ASTM D7400 (if applicable). This minimum data include q_t, f_s, and u. Other correlated parameters may also be provided. These other correlated parameters are interpretations of the measured data based upon published and reliable references, but they do not necessarily represent the actual values that would be derived from direct testing to determine the various parameters. To this end, more than one correlation to a given parameter may be provided. The following chart illustrates estimates of reliability associated with correlated parameters based upon the literature referenced below.

RELATIVE RELIABILITY OF CPT CORRELATIONS



* improves with seismic V_s measurements

Reliability of CPT-predicted N_{60} values as commonly measured by the Standard Penetration Test (SPT) is not provided due to the inherent inaccuracy associated with the SPT test procedure.

WATER LEVEL

The groundwater level at the CPT location is used to normalize the measurements for vertical overburden pressures and as a result influences the normalized soil behavior type classification and correlated soil parameters. The water level may either be "measured" or "estimated:"

Measured - Depth to water directly measured in the field

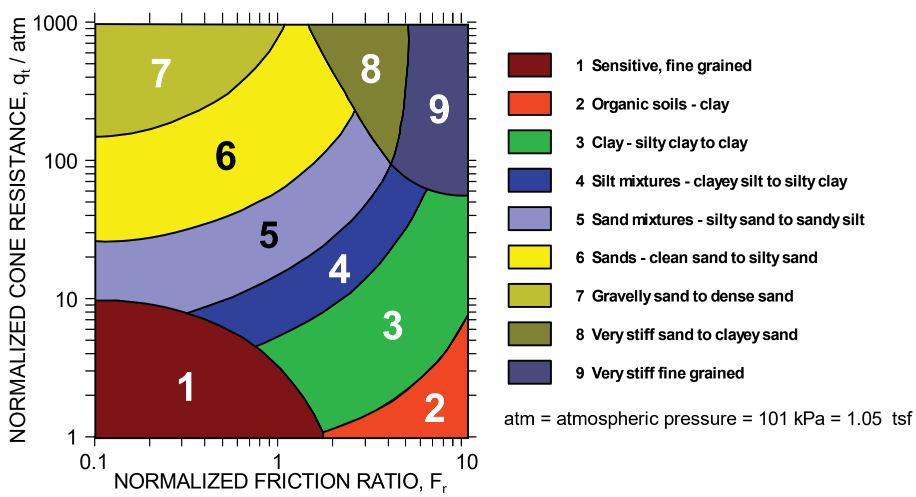
Estimated - Depth to water interpolated by the practitioner using pore pressure measurements in coarse grained soils and known site conditions

While groundwater levels displayed as "measured" more accurately represent site conditions at the time of testing than those "estimated," in either case the groundwater should be further defined prior to construction as groundwater level variations will occur over time.

CONE PENETRATION SOIL BEHAVIOR TYPE

The estimated stratigraphic profiles included in the CPT logs are based on relationships between corrected tip resistance (q_t), friction resistance (f_s), and porewater pressure (u_2). The normalized friction ratio (F_r) is used to classify the soil behavior type.

Typically, silts and clays have high F_r values and generate large excess penetration porewater pressures; sands have lower F_r's and do not generate excess penetration porewater pressures. The adjacent graph (Robertson *et al.*) presents the soil behavior type correlation used for the logs. This normalized SBT chart, generally considered the most reliable, does not use pore pressure to determine SBT due to its lack of repeatability in onshore CPTs.



atm = atmospheric pressure = 101 kPa = 1.05 tsf

REFERENCES

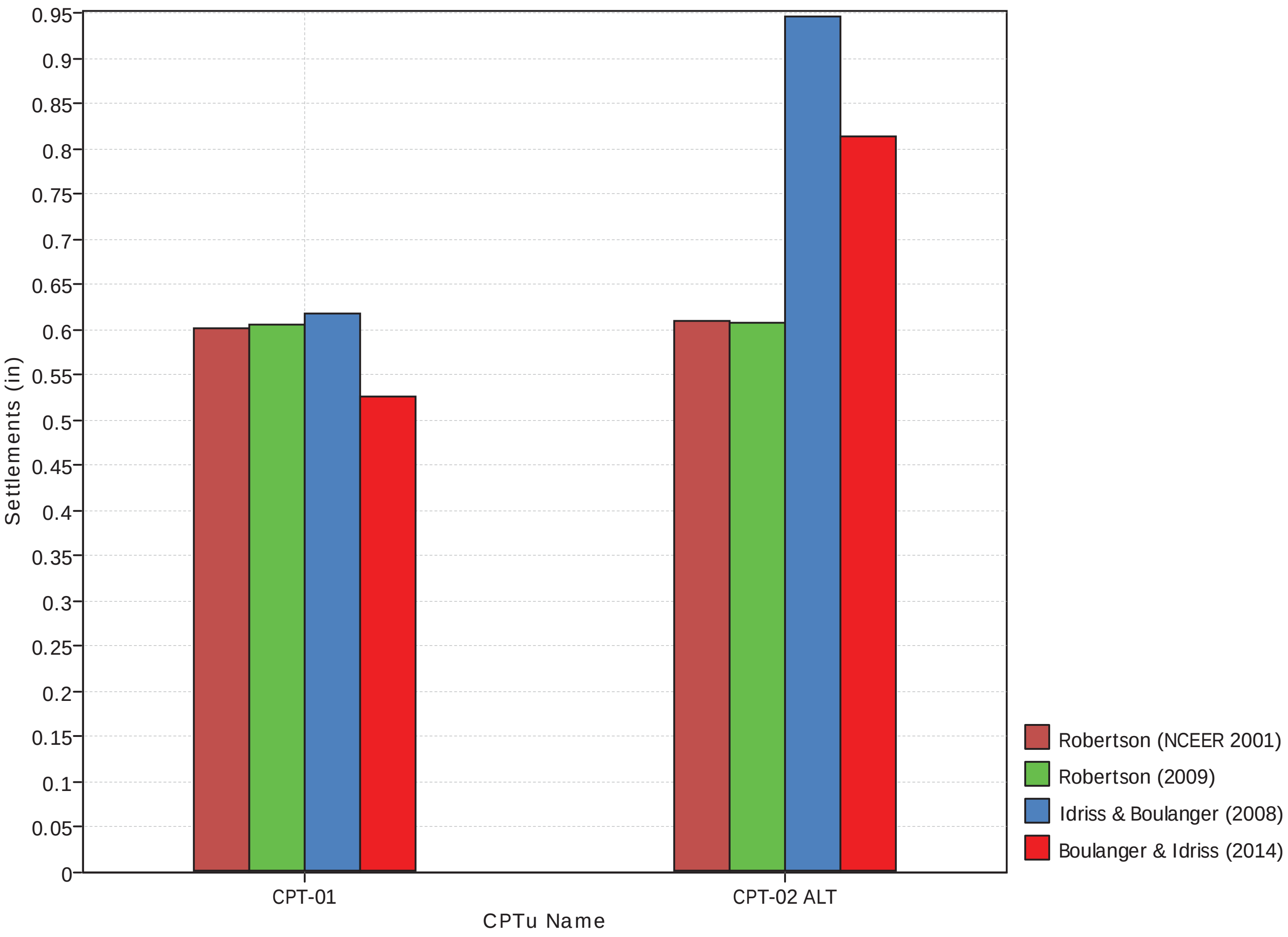
Kulhawy, F.H., Mayne, P.W., (1997). "Manual on Estimating Soil Properties for Foundation Design," Electric Power Research Institute, Palo Alto, CA.

Mayne, P.W., (2013). "Geotechnical Site Exploration in the Year 2013," Georgia Institue of Technology, Atlanta, GA.

Robertson, P.K., Cabal, K.L. (2012). "Guide to Cone Penetration Testing for Geotechnical Engineering," Signal Hill, CA.

Schmertmann, J.H., (1970). "Static Cone to Compute Static Settlement over Sand," *Journal of the Soil Mechanics and Foundations Division*, 96(SM3), 1011-1043.

Overall Parametric Assessment Method



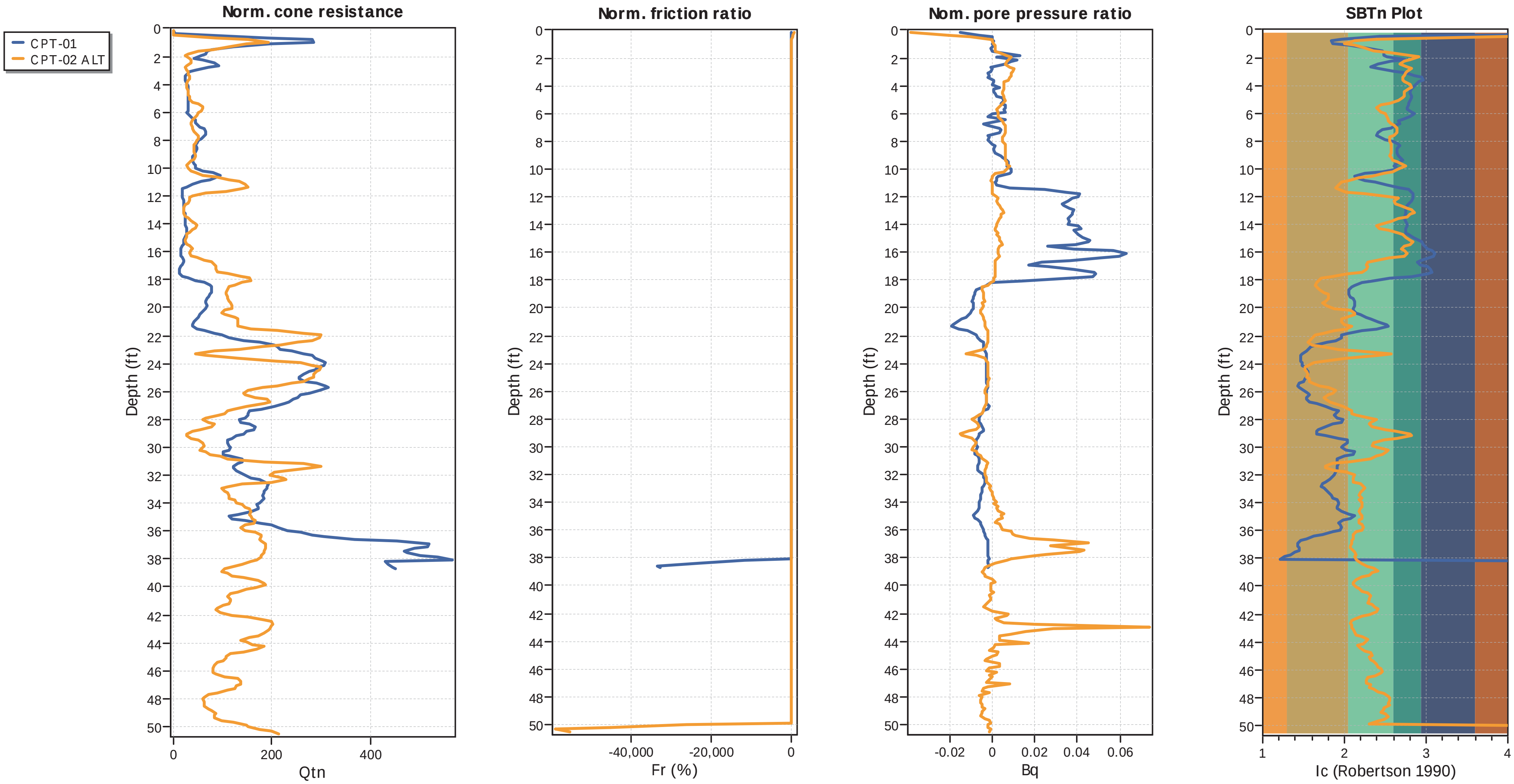
:: CPT main liquefaction parameters details ::

CPT Name	Earthquake Mag.	Earthquake Accel.	GWT in situ (ft)	GWT earthq. (ft)
CPT-01	6.63	0.66	18.00	10.00
CPT-02 ALT	6.63	0.66	18.00	10.00

Terracon Consultants, Inc.
5075 Commercial Cir., Suite E
Concord, CA 94520
www.terracon.com

Project:

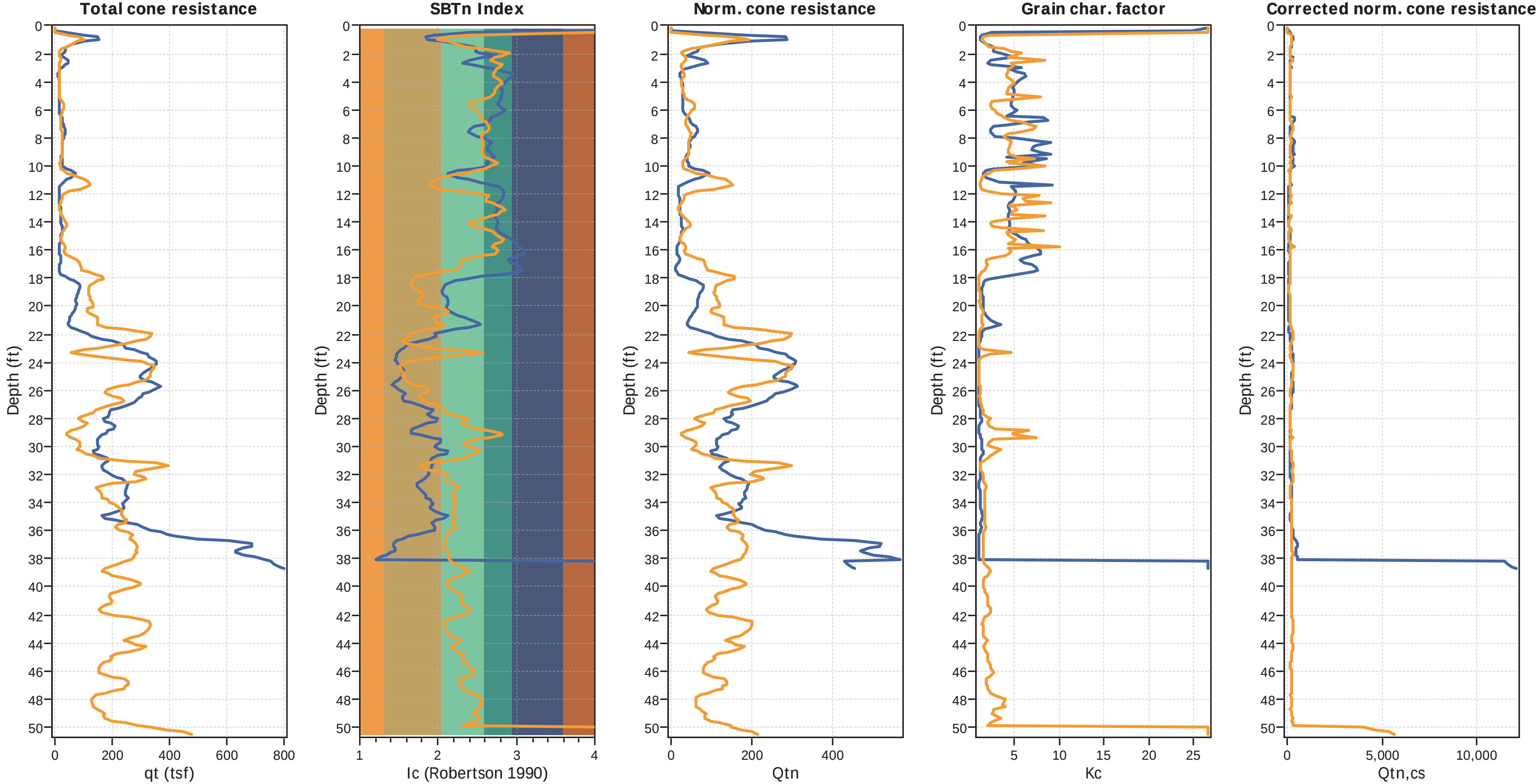
Overlay Normalized Plots



Terracon Consultants, Inc.
5075 Commercial Cir., Suite E
Concord, CA 94520
www.terracon.com

Project:

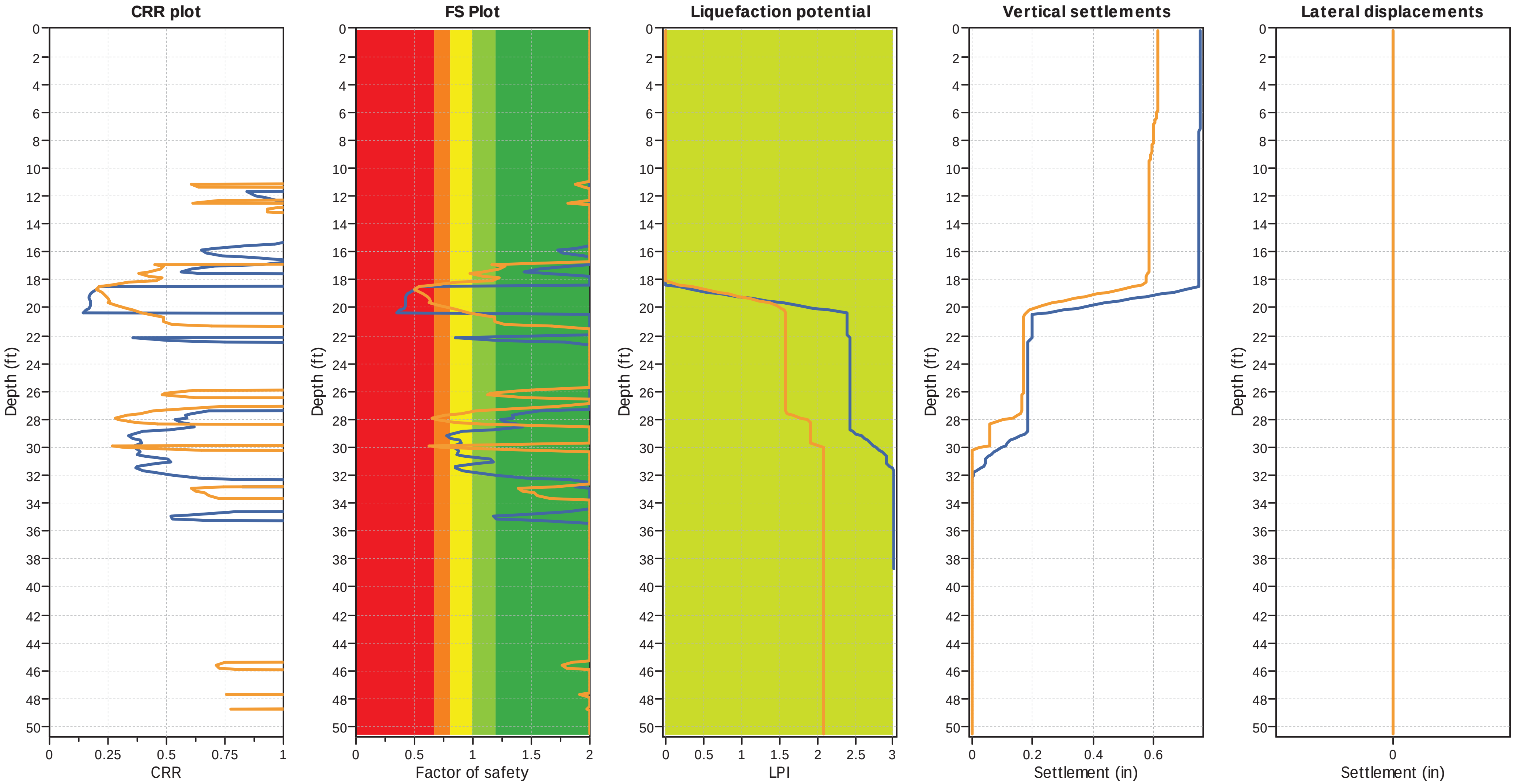
Overlay Intermediate Results



Terracon Consultants, Inc.
5075 Commercial Cir., Suite E
Concord, CA 94520
www.terracon.com

Project:

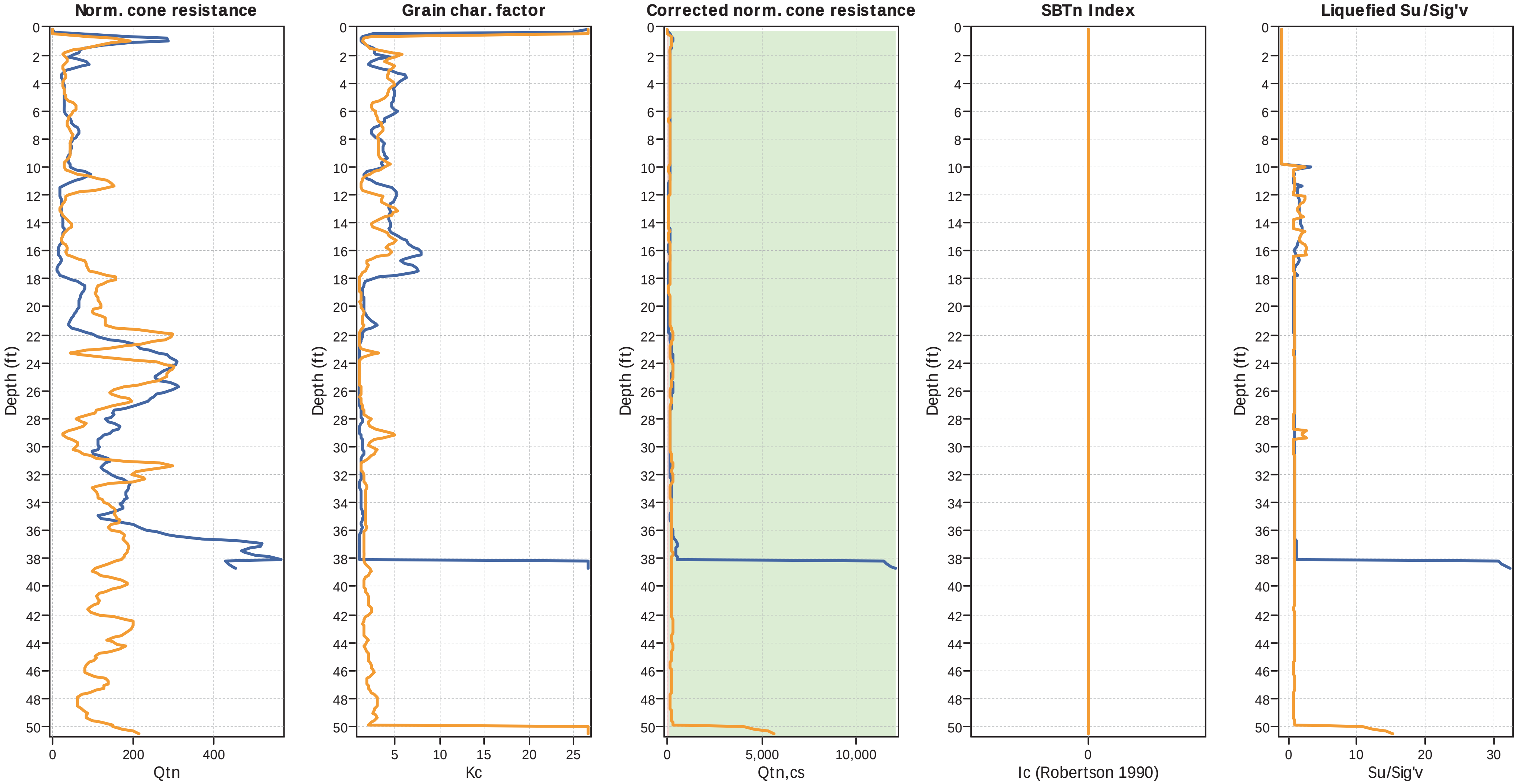
Overlay Cyclic Liquefaction Plots



Terracon Consultants, Inc.
5075 Commercial Cir., Suite E
Concord, CA 94520
www.terracon.com

Project:

Overlay Strength Loss Plots

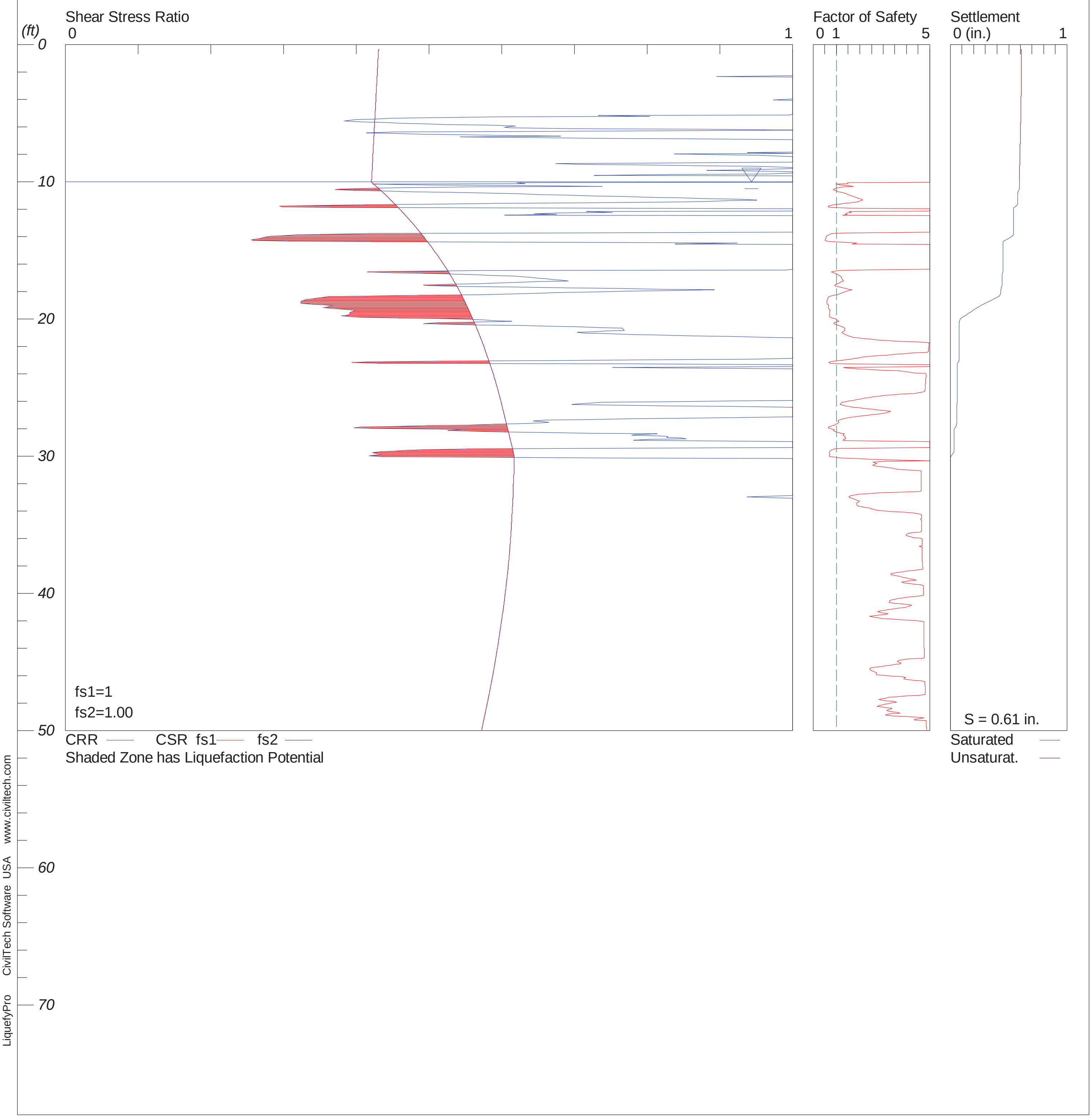


LIQUEFACTION ANALYSIS

Cambria Hotel Liquefaction

Hole No.=CPT-2 Water Depth=10 ft Surface Elev.=72

Magnitude=6.63
Acceleration=0.663g



Terracon Consultants, Inc.