Geotechnical Engineering Report

Houston Middle School Relocatable Buildings Project
Acampo, California
December 14, 2018
Terracon Project No. NA185174

Prepared for:
Lodi Unified School District
Lodi, California

Prepared by:
Terracon Consultants, Inc.
Lodi, California

December 14, 2018

Lodi Unified School District
1305 E. Vine Street
Lodi, California 95240

Attn: Leonard Kahn
P: (209) 331-7122
E: lkahn@lodiusd.net

Re: Geotechnical Engineering Report
Houston Middle School Relocatable Buildings Project
4600 Acampo Road
Acampo, California
Terracon Project No. NA185174

Dear Mr. Kahn:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. PNA185174 dated October 26, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements 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.

Patrick C. Dell, Senior Associate
Geotechnical Engineer 2186
Geotechnical Department Manager

Garret S.H. Hubbart, Principal
Geotechnical Engineer 2588
Office Manager

REPORT TOPICS

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 ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

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4600 Acampo Road
Acampo, California
Terracon Project No. NA185174
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INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering services performed for the proposed relocatable buildings project to be located at 4600 Acampo Road in Acampo, 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
- Seismic site classification per 2016 CBC
- Foundation design and construction
- Floor slab design and construction
- Excavation considerations
- Pavement recommendations

The geotechnical engineering Scope of Services for this project included the advancement of six (6) test borings to depths ranging from approximately 6½ to 11½ feet below existing site grades.

Maps showing the site and boring 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 in the **Exploration Results** section.

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 4600 Acampo Road in Acampo, California. Approximate project coordinates: 38.174˚N 121.259˚W. See **Site Location**
Existing Improvements	The project site is currently an operating elementary school with buildings, pavements, and landscaped areas.
Current Ground Cover	Pavement and lawn.

Item	Description
Existing Topography	The project site is relatively flat.

PROJECT DESCRIPTION

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

Item	Description
Information Provided	The information regarding the planned construction was provided to us in an email from Stephen Henry with Henry & Associates Architects. The email was received on October 23, 2018. Mr. Henry provided a preliminary site development plan in his email. On December 11, 2018 we were provided with the tank design drawings sheets F1.0 and F1.1 prepared by Sauers Engineering Inc. dated 10/30/18 and the civil drawings prepared by Warren Consulting Engineers, Inc. dated 10/30/18.
Project Description	We understand the project will consist of moving 8 relocatable classroom buildings at Houston Middle School to a different location onsite, to the east of the existing campus. The parking lot and bus lane will be expanded, and a fire water tank will be added towards the south end of the campus.
Proposed Structures	Eight (8) relocatable classroom buildings, one (1) 20,000-gallon fire water tank, 24 feet in diameter and 12 feet tall.
Building Construction	Relocatable buildings will be placed on wood foundations and floors will be supported on compacted aggregate base pads. The water tank will be constructed on a 26-foot diameter concrete slab-on-grade pad.
Finished Floor Elevation	Unknown.
Maximum Loads	Buildings: ■ Columns: 10 to 20 kips ■ Walls: 1 to 2 kips per linear foot (klf) ■ Slabs: 150 pounds per square foot (psf) Water Tank: ■ Area load: 750 psf
Grading/Slopes	Up to 2 feet of cut and 2 feet of fill may be required to provide level pads for the structures.
Pavements	Expanded parking lot and bus lane. Bus traffic will be about 10 bus trips per day.
Estimated Start of Construction	Unknown.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project.

The near surface soils encountered in our borings consisted of very loose to medium dense silty sand and sandy silt that extended to depths of between 3½ and 7 feet below the existing ground surface (bgs). These soils were underlain by interbedded layers of medium dense to very dense silty sand which was weakly cemented in places and medium dense sandy silt that extended to the maximum depths explored.

Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section.

GEOTECHNICAL OVERVIEW

The near surface silty and sandy soils are loose to medium dense. In order to provide uniform support for the relocatable classroom buildings, all foundations should bear on a minimum of 18 inches of compacted native soil or non-expansive engineered fill. The mat slab foundation for the fire water tank should bear on 12 inches of Class 2 aggregate base overlying 18 inches of compacted native soil. Additional site preparation recommendations, including subgrade improvement and fill placement, are provided in the **Earthwork** section.

The **Pavements** section addresses the design of pavement systems.

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

EARTHWORK

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

Site Preparation

Prior to placing fill, existing vegetation and root mat should be removed. Complete stripping of the topsoil should be performed in the proposed structures and parking/driveway areas.

The subgrade should be proofrolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck or water truck. The proofrolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed and replaced with engineered fill or modified by stabilizing with lime or cement or utilization of a geotextile. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted.

Fill Material Types

All fill materials should be inorganic soils free of vegetation, debris, and fragments larger than three inches in size. Pea gravel or other similar non-cementitious, poorly-graded materials should not be used as fill or backfill without the prior approval of the geotechnical engineer.

Imported earth materials for use as engineered fill should be pre-approved by our representative prior to construction. Imported non-expansive soils may be used as fill material for the following:

- general site grading
- foundation areas
- slab-on-grade floor
- pavement subgrade
- foundation backfill
- trench backfill
- exterior slabs-on-grade

Soils for use as compacted engineered fill material within the proposed building and tank areas should conform to non-expansive materials as indicated in the following recommendations:

Gradation	Percent Finer by Weight (ASTM C 136)
3”	100
No. 4 Sieve	50 - 100
No. 200 Sieve	15 - 50

- Liquid Limit 30 (max)
- Plasticity Index 10 (max)
- Maximum Expansive Index* 20 (max)

*ASTM D 4829

The on-site sands should meet the specifications above. Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift. Fill lifts should not exceed ten inches in loose thickness.

Fill Compaction Requirements

Recommended compaction and moisture content criteria for engineered fill materials are as follows:

Material Type and Location	Per the Modified Proctor Test (ASTM D 1557)		
	Minimum Compaction Requirement (%)	Range of Moisture Contents for Compaction above Optimum	
		Minimum	Maximum
On-site sandy soils and Low volume change (non-expansive) imported fill:			
Beneath foundations:	90	0%	+3%
Beneath floors	90	0%	+3%
Beneath pavements	95	0%	+3%
Miscellaneous backfill:	90	0%	+3%
Utility Trenches*:	90	0%	+4%
Bottom of native soil excavation receiving fill:	90	+1%	+4%

*The upper 12 inches beneath pavement should be compacted to 95% of the maximum dry density as determined in the ASTM D1557 test method.

We recommend that compacted native soil or any engineered fill be tested for moisture content and relative compaction during placement. Should the results of the in-place density tests indicate the specified moisture content or compaction requirements have not been met, the area represented by the test should be reworked and retested as required until the specified moisture content and relative compaction requirements are achieved.

Utility Trench Backfill

Utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the buildings should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the buildings. 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.

Grading and Drainage

All grades must provide effective drainage away from the buildings during and after construction and should be maintained throughout the life of the structures. Water retained next to the buildings 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 roofs should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the buildings.

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

Earthwork Construction Considerations

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

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

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

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and topsoil, proofrolling, and mitigation of areas delineated by the proofroll 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 1,500 square feet of compacted fill in the building areas and 2,500 square feet in pavement areas. One density and water content test should be performed for every 12-inch thick lift for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If 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

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations. Foundations for the relocatable buildings may be designed in accordance with the following recommendations.

Building Design Parameters – Compressive Loads

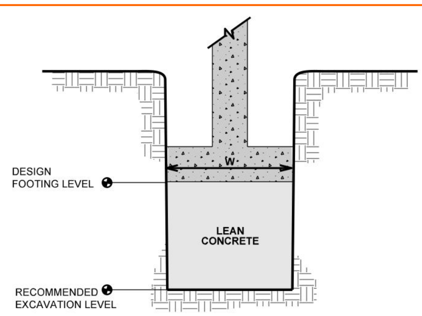
Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	2,000 psf
Required Bearing Stratum [3]	18 inches of compacted native soil or non-expansive engineered fill
Minimum Foundation Dimensions	Columns: 36 inches Continuous: 12 inches
Maximum Foundation Dimensions	Columns: 60 inches Continuous: 36 inches
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	350 pcf
Ultimate Coefficient of Sliding Friction [5]	0.40
Minimum Embedment below Finished Grade [6]	12 inches
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About ½ of total settlement

Item	Description
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. Values assume that exterior grades are relatively flat adjacent to the structure.
2.	Values provided are for maximum loads noted in **Project Description**.
3.	Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4.	Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face.
5.	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. If passive resistance is combined with base friction to resist lateral movement, the coefficient of sliding friction should be reduced by 25 percent.
6.	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.
7.	Differential settlements are as measured over a span of 40 feet.

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 foundations. The foundations should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundations are placed.

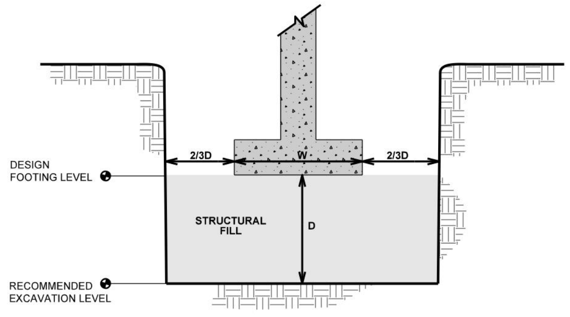
If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on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



LEAN CONCRETE BACKFILL

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

Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation with engineered fill placed as recommended in the **Earthwork** section.



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.

FIRE WATER TANK FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for the tank mat foundation. The mat slab foundation for the fire water tank may be designed in accordance with the following recommendations.

Building Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	1,500 psf
Required Bearing Stratum [3]	18 inches of compacted native soil
Mat Slab Foundation Support	12 inches compacted Class 2 aggregate base
Ultimate Passive Resistance [4] **(equivalent fluid pressures)**	350 pcf
Ultimate Coefficient of Sliding Friction [5]	0.40
Minimum Embedment below Finished Grade [6]	12 inches

Item	Description
Estimated Total Settlement from Structural Loads [2]	Less than about 1 inch
Estimated Differential Settlement [2, 7]	About ½ 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. Values assume that exterior grades are relatively flat adjacent to the structure.
2. Values provided are for maximum loads noted in **Project Description**.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the **Earthwork**.
4. Use of passive earth pressures require the sides of the excavation for the mat slab 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.
5. 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. If passive resistance is combined with base friction to resist lateral movement, the coefficient of sliding friction should be reduced by 25 percent.
6. 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.
7. Differential settlements are as measured over a span of 40 feet.

SEISMIC CONSIDERATIONS

The seismic design requirements for the project 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	38.1743° N
Site Longitude	121.2604° W
S_s Spectral Acceleration for a Short Period	0.703g
S_1 Spectral Acceleration for a 1-Second Period	0.291g
F_a Site Coefficient for a Short Period	1.238
F_v Site Coefficient for a 1-Second Period	1.819
S_{Ms} Maximum Considered Spectral Response Acceleration for a Short Period	0.870g
S_{M1} Maximum Considered Spectral Response Acceleration for a 1-Second Period	0.529g
S_{DS} Design Spectral Acceleration for a Short Period [3]	0.580g
S_{D1} Spectral Acceleration for a 1-Second Period [3]	0.352g
PGA_M Peak Ground Acceleration	0.317g

1. Seismic site classification in general accordance with the *2016 California Building Code*, which refers to ASCE 7-10 with March 2013 errata.
2. The 2016 California Building Code (CBC) uses a site profile extending to a depth of 100 feet for seismic site classification. Borings at this site were extended to a maximum depth of 11½ feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.
3. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

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 non-plastic 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 is not located within a liquefaction hazard zone mapped by the CGS.

Due to the historical “high” depth to groundwater being greater than 50 feet below the existing grade, in our opinion the potential for liquefaction to occur at this site is low. Accordingly, potential other effects of liquefaction, such as lateral spreading, etc. are low.

Given the relative density of the soils encountered in our borings, the potential for dry sand settlement to occur and negatively affect the buildings is considered low and not a concern in the design of these buildings.

FLOOR SUPPORT

Floor Support Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 4 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed drain rock. At least 12 inches of compacted native soil or engineered fill
Estimated Modulus of Subgrade Reaction [2]	150 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings 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. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

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.

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.

Pavement Design Parameters

Design of Asphaltic Concrete (AC) pavements are based on the procedures in the Caltrans Highway Design Manual, 2012 edition. Design of Portland Cement Concrete (PCC) pavements are based upon American Concrete Institute (ACI) 330R-01; Guide for Design and Construction of Concrete Parking Lots.

One sample of the near surface soils was obtained from the proposed expanded parking lot and bus lane area and tested to determine its Resistance Value (R-value). The test produced an R-value of 30. A design R-value of 30 was used for the AC and PCC pavement designs. We are providing pavement recommendations for traffic indices (TI) between 5.0 and 7.5. If different traffic loading or traffic index is required, our office shall be contacted to prepare additional pavement sections. The project civil engineer should be afforded the opportunity to determine the most appropriate traffic index (TI) for the project.

Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

Conventional Asphaltic Concrete Design				
Layer	**Thickness (inches)**			
	TI=5.0[1]	**TI=6.0[1]**	**TI=7.0[1]**	**TI=7.5[1]**
AC [2]	3.0	3.5	4.0	4.5
Aggregate Base	5.5	7.5	9.5	10.5

1. **See Project Description for more specifics regarding traffic classifications.**
2. **All materials should meet the current California Department of Transportation (Caltrans) Standard Specifications, latest edition.**

Portland Cement Concrete Design				
Layer	**Thickness (inches)**			
	TI=5.0[1]	**TI=6.0[1]**	**TI=7.0[1]**	**TI=7.5[1]**
PCC	5.0	5.0	5.5	6.0
Aggregate Base	4.0	4.0	4.0	4.0

1. **See Project Description for more specifics regarding traffic classifications.**
2. **All materials should meet the current California Department of Transportation (Caltrans) Standard Specifications, latest edition.**

The estimated pavement sections provided in this report are minimums for the assumed design criteria, and as such, periodic maintenance should be expected. Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles. A maintenance program including surface sealing, joint cleaning and sealing, and timely repair of cracks and deteriorated areas will increase the pavement's service life. As an option, thicker sections could be constructed to decrease future maintenance.

Concrete for rigid pavements should have a minimum 28-day compressive strength of 4,000 psi and be placed with a maximum slump of 4 inches. Although not required for structural support, a minimum 4-inch thick base course layer is recommended to help reduce potential for slab curl, shrinkage cracking, and subgrade pumping through joints. Proper joint spacing will also be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

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.

Pavement design methods are intended to provide structural sections with adequate thickness over a subgrade such that wheel loads are reduced to a level the subgrade can support.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. This is especially applicable for islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils. The civil design for the pavements with these conditions should include features to restrict or to collect and discharge excess water from the islands. Examples of features are edge drains connected to the storm water collection system, longitudinal subdrains, or other suitable outlet and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Dishing in parking lots surfaced with ACC is usually observed in frequently-used parking stalls (such as near the front of buildings) and occurs under the wheel footprint in these stalls. The use of higher-grade asphaltic cement, or surfacing these areas with PCC, should be considered. The dishing is exacerbated by factors such as irrigated islands or planter areas, sheet surface drainage to the front of structures, and placing the ACC directly on a compacted clay subgrade.

Rigid PCC pavements will perform better than ACC 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. 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.

PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with American Concrete Institute (ACI 330R-01 and ACI 325R.9-91). PCC pavements should be provided with mechanically reinforced joints (doweled or keyed) in accordance with ACI 330R-01.

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.

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 t slabs, since it could saturate the subgrade and contribute to premature pavement or slab deterioration.

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.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing performed on one sample obtained from boring B2 at a depth of 1 foot. 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**
B4	1-2½	Silty Sand	63	88	10670	8.63

The sulfate test results indicate that the soil from boring B2 classifies as Class S0 according to Table 19.3.1.1 of ACI 318-14. This indicates that the sulfate level is negligible when considering corrosion to concrete.

The chloride test results indicate that the soils have a relatively low chloride content present. According to Table 19.3.1.1 of ACI 318-14, the soil should not be considered an external source of chloride (i.e. sea water, etc.) to concrete foundations. Consequently, chloride classes of C0 and C1 should be used where applicable. C0 is defined as, “Concrete dry or protected from moisture” and C1 is defined as, “Concrete exposed to moisture but not to an external source of chlorides”. For the amount of chlorides allowed in concrete mix designs, Table 19.3.2.1 of ACI 318-14 shall be adhered to as appropriate.

Based on the results of the sulfate content test results, ACI 318-14, Section 19.3 does not specify the type of cement or a maximum water-cement ratio for concrete for sulfate Class S0. For further information, see ACI 318-14, Section 19.3.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. 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 this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

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

Our services and any correspondence 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

Number of Borings	Boring Depth (feet)	Planned Location
5	11½	Planned building and water tank areas
1	6 ½	Planned parking lot expansion and bus lane area

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±10 feet) and approximate elevations were obtained by interpolation from Google Earth™ aerial photos. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted rotary drill rig using continuous flight hollow stem augers. Samples were obtained at depths of 1 and 5 feet and at intervals of 5 feet thereafter. In the split-barrel sampling procedure, a 2.5-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration was recorded as the blow counts. Tube-lined, split-barrel sampling procedures are similar to standard split spoon (SPT) sampling procedure; however, blow counts are not equivalent to SPT blow counts. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings or neat cement grout after their completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials 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.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to 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 were 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 D1140 Standard Test Method for Determining the Amount of Material Finer than No. 200 Sieve by Soil Washing

- Corrosivity Test

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

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Houston Middle School Relocatable Buildings Project ■ Acampo, California
December 14, 2018■ Terracon Project No. NA185174

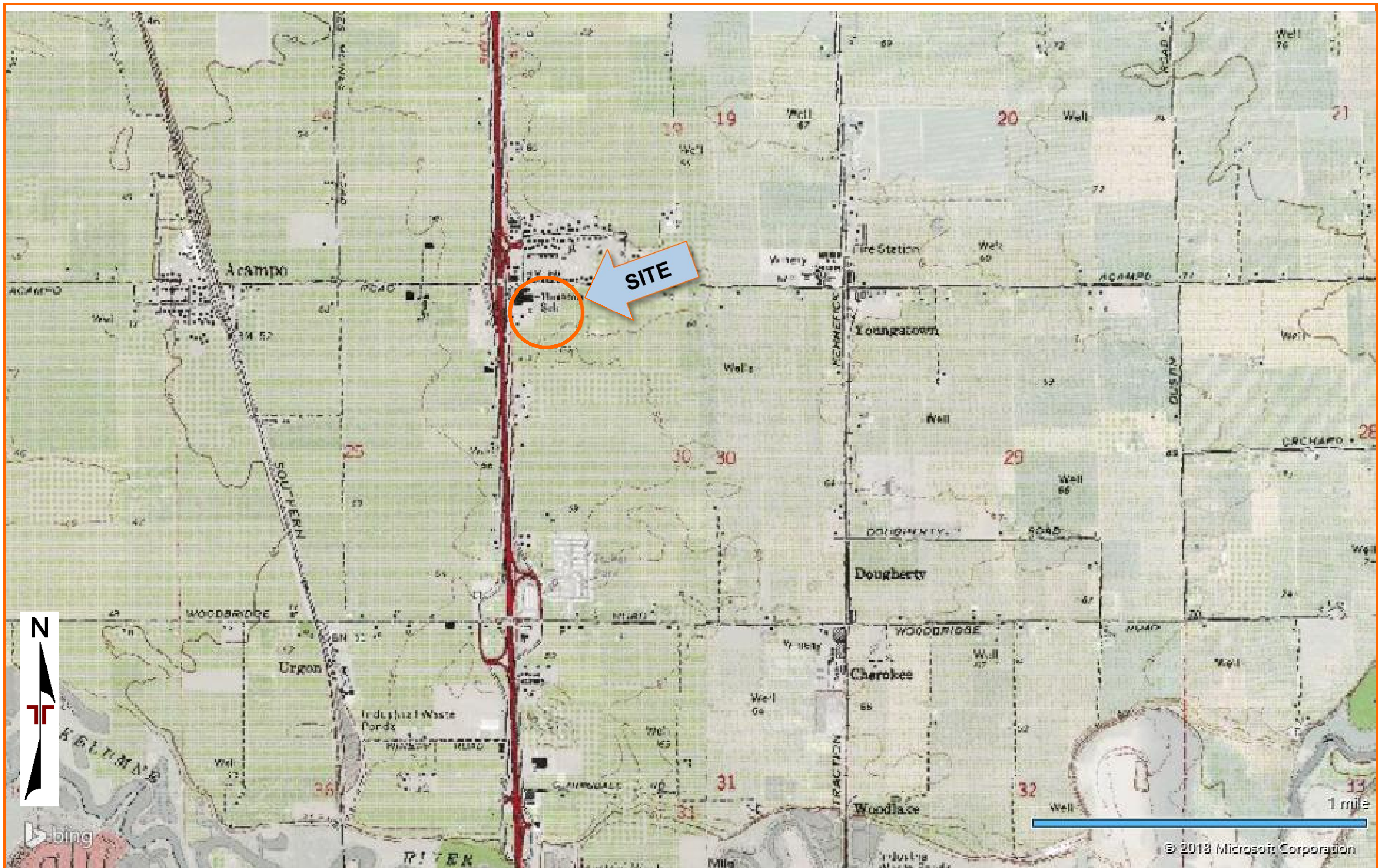


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Houston Middle School Relocatable Buildings Project ■ Acampo, California
December 14, 2018 ■ Terracon Project No. NA185174

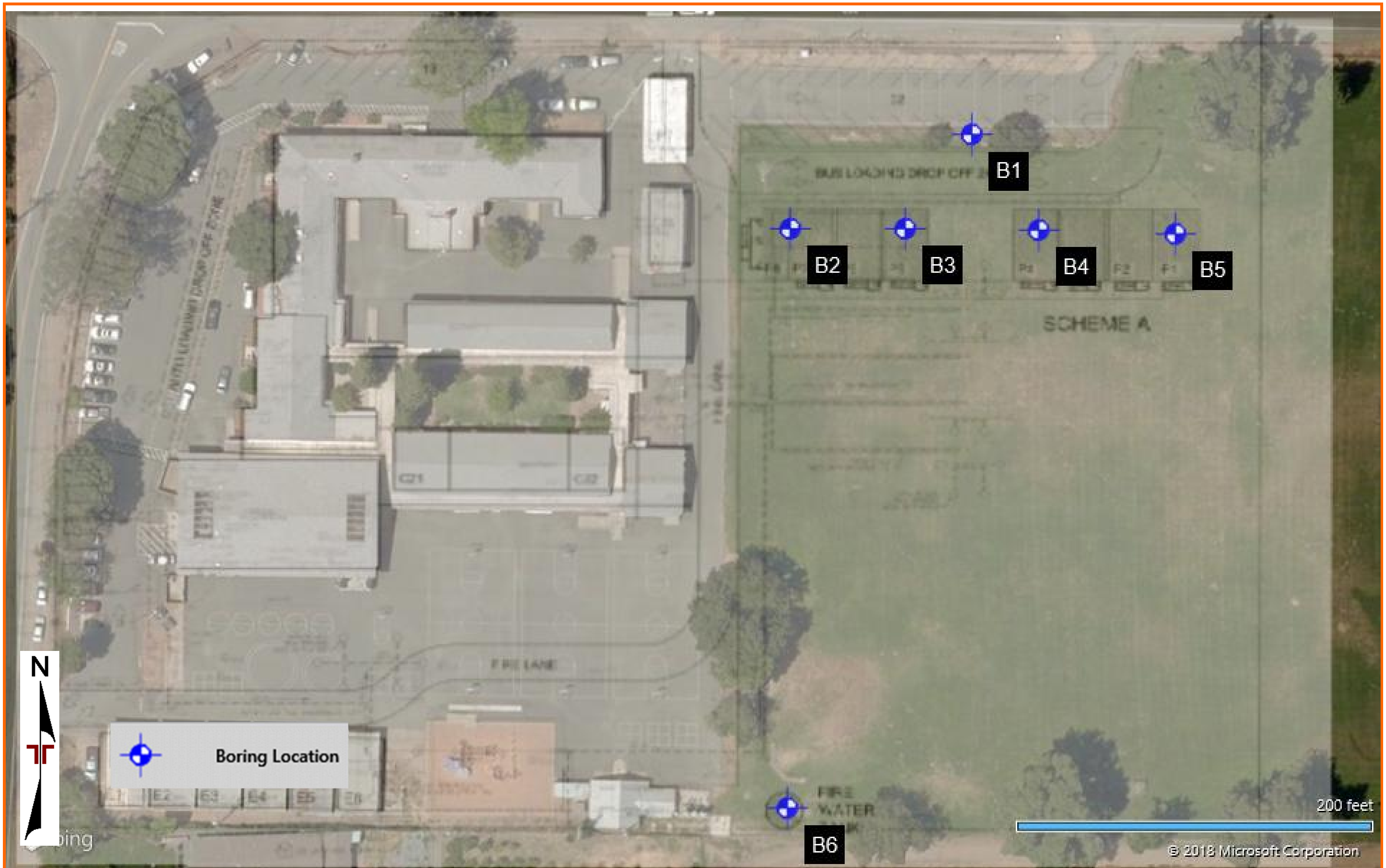


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Note: All attachments are one page unless noted above.

BORING LOG NO. B1

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District, Lodi, CA

SITE: 4600 Acampo Road, Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1745° Longitude: -121.26°

Approximate Surface Elev: 62 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SILTY SAND (SM), fine to medium grained, brown, loose									
				Split spoon	3-3-4	9	113		
		5		Split spoon	5-6-6	8	113		
light brown, medium dense; 6.5	55.5+/-								
Boring Terminated at 6.5 Feet									

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

Hammer Type: Automatic

Advancement Method:
6" Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings 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.

Elevations estimated using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

BORING LOG NO. B2

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District
Lodi, CA

SITE: 4600 Acampo Road
Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1743° Longitude: -121.2604°

Approximate Surface Elev: 62 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY SILT (ML), fine to medium grained, brown, very loose									
						2-1-2	14	117		
			5			2-4-4	16	114	NP	61
	medium dense, rust mottling									
8.0		54+/-								
	SILTY SAND (SM), fine to medium grained, orange brown, medium dense to weakly cemented									
			10			11-44-50/4"	12	122		
11.5		50.5+/-								
	Boring Terminated at 11.5 Feet									

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

Hammer Type: Automatic

Advancement Method:
6" Hollow 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.

Elevations estimated using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

BORING LOG NO. B3

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District, Lodi, CA

SITE: 4600 Acampo Road, Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1743° Longitude: -121.2601°

Approximate Surface Elev: 62 (Ft.) +/-

GRAPHIC LOG	DEPTH / MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY SILT (ML), fine to medium grained, brown, loose									
						3-3-4	9	103		55
			5			4-7-7	13	107		
	medium dense									
	light brown, rust mottling									
	8.5	53.5+/-								
	SILTY SAND (SM), fine to medium grained, brown, medium dense, rust mottling									
			10			8-18-24	14	118		
	11.5	50.5+/-								
	Boring Terminated at 11.5 Feet									

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

Hammer Type: Automatic

Advancement Method:
6" Hollow 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.

Elevations estimated using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

BORING LOG NO. B4

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District, Lodi, CA

SITE: 4600 Acampo Road, Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1743° Longitude: -121.2599°

Surface Elev.: 62 (Ft.)

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), fine to medium grained, brown, very loose									
							2-1-2	12	106		
		very loose		5			1-1-2	14	114		
		medium dense		10			3-3-6	18			
	11.5		50.5								
		Boring Terminated at 11.5 Feet									

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

Hammer Type: Automatic

Advancement Method:
6" Hollow 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.

Elevations estimated using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

BORING LOG NO. B5

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District
Lodi, CA

SITE: 4600 Acampo Road
Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1743° Longitude: -121.2596°

Approximate Surface Elev: 62 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND (SM), fine to medium grained, brown, loose									
							2-2-2	15	99		
	3.5		58.5+/-								
		SANDY SILT (ML), fine to medium grained, light tan, medium dense, rust mottling									
				5			12-21-15	25	94		
	8.0		54+/-								
		SILTY SAND (SM), fine to medium grained, orange brown, rust mottling dense to weakly cemented									
				10			9-22-43	14	122		
	11.5		50.5+/-								
		Boring Terminated at 11.5 Feet									

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

Hammer Type: Automatic

Advancement Method:
6" Hollow 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.

Elevations estimated using Google Earth

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

BORING LOG NO. B6

PROJECT: Houston Middle School Relocatable Buildings Project

CLIENT: Lodi Unified School District
Lodi, CA

SITE: 4600 Acampo Road
Acampo, CA

LOCATION See Exploration Plan

Latitude: 38.1735° Longitude: -121.2603°

Surface Elev.: 62 (Ft.)

GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND (SM), fine to medium grained, brown, medium dense								
				X	5-5-4	9	115		44
	medium dense	5		X	8-8-10	6	111		
	orange brown, medium dense	10		X	7-9-11	11	113		
	11.5 / 50.5								
	Boring Terminated at 11.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
6" Hollow 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.

Elevations estimated using Google Earth

Notes:

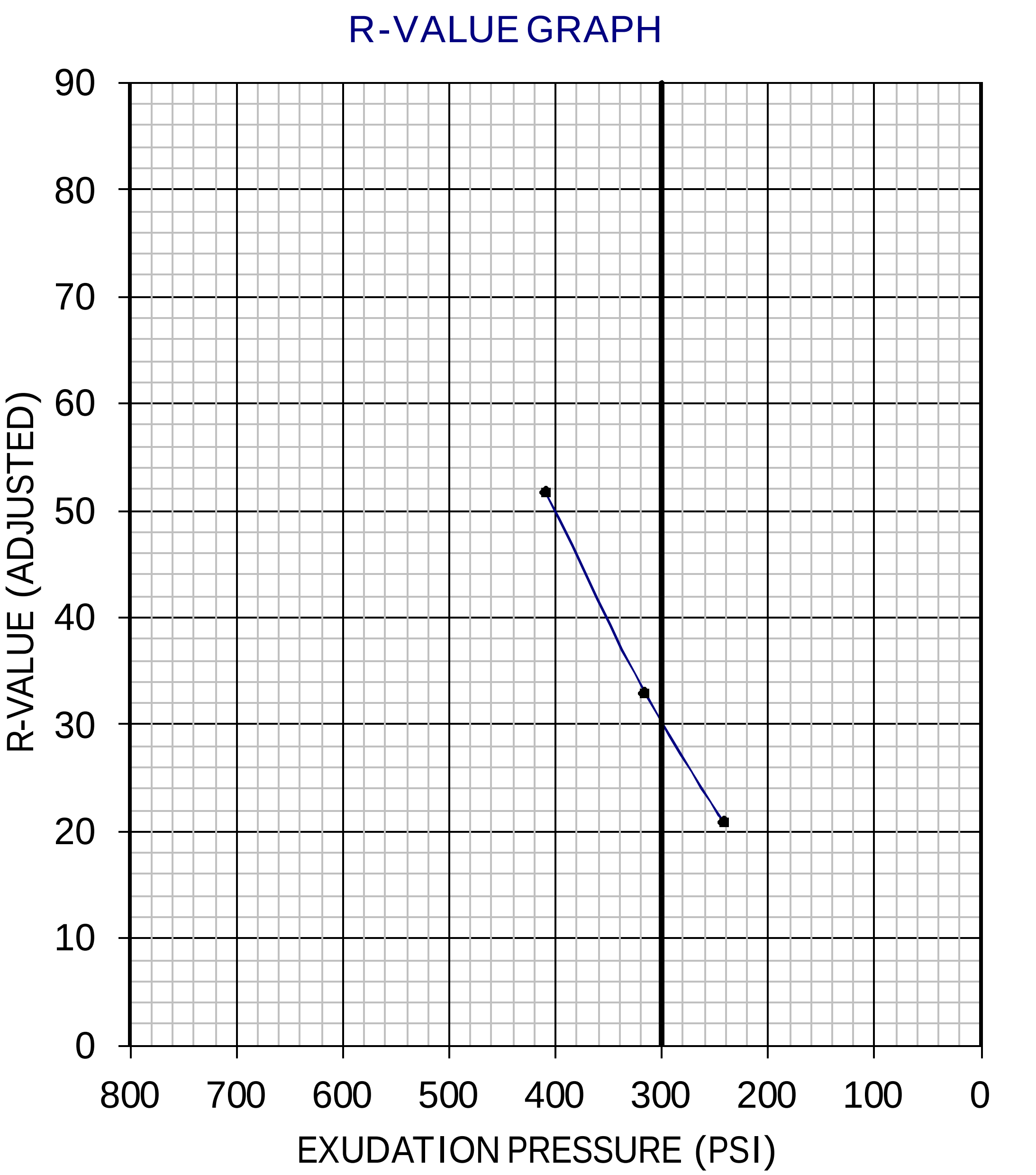
WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
902 Industrial Way
Lodi, CA

Boring Started: 11-02-2018	Boring Completed: 11-02-2018
Drill Rig: CME-75	Driller: R. Anderson
Project No.: NA185174	

JOB NAME: Houston Elementary School Relocatables
JOB #: NA185174
SAMPLE NUMBER: B-1
Location: Native
SAMPLE CLASSIFICATION: Sandy Silt



R-VALUE AT 300 PSI EXUDATION PRESSURE: 30

NOTES:

CHEMICAL LABORATORY TEST REPORT

Project Number: NA185174
Service Date: 12/13/18
Report Date: 12/14/18
Task:

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

Client

Lodi Unified School District
Lodi, CA

Project

Houston Middle School Relocatable Buildings Project

Sample Submitted By: Terracon (NA) **Date Received:** 12/12/2018 **Lab No.: 18-1506**

Results of Corrosion Analysis

Sample Number	1
Sample Location	B4
Sample Depth (ft.)	1.0-2.5
pH Analysis, ASTM G 51	8.63
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	63
Sulfides, AWWA 4500-S D, (mg/kg)	Nil
Chlorides, ASTM D 512, (mg/kg)	88
Red-Ox, AWWA 2580, (mV)	+686
Total Salts, AWWA 2520 B, (mg/kg)	209
Resistivity, ASTM G 57, (ohm-cm)	10670

Analyzed By: Trisha Campo
Trisha Campo
Chemist

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Houston Middle School Relocatable Buildings Project ■ Acampo, CA
December 14, 2018 ■ Terracon Project No. NA185174

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS	
Modified California Ring Sampler	**Water Initially Encountered**	**N**	**Standard Penetration Test Resistance (Blows/Ft.)**
	Water Level After a Specified Period of Time	**(HP)**	**Hand Penetrometer**
	Water Level After a Specified Period of Time	**(T)**	**Torvane**
	Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**(DCP)**	**Dynamic Cone Penetrometer**
		UC	**Unconfined Compressive Strength**
		(PID)	**Photo-Ionization Detector**
		(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**	**Ring Sampler Blows/Ft.**
Very Loose	0 - 3	0 - 6	Very Soft	less than 0.25	0 - 1	< 3
Loose	4 - 9	7 - 18	Soft	0.25 to 0.50	2 - 4	3 - 4
Medium Dense	10 - 29	19 - 58	Medium Stiff	0.50 to 1.00	4 - 8	5 - 9
Dense	30 - 50	59 - 98	Stiff	1.00 to 2.00	8 - 15	10 - 18
Very Dense	> 50	> 99	Very Stiff	2.00 to 4.00	15 - 30	19 - 42
			Hard	> 4.00	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL		RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12
GRAIN SIZE TERMINOLOGY		**PLASTICITY DESCRIPTION**	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

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 ³ 4 and 1 £ Cc £ 3 E		GW	Well-graded gravel F
			Cu < 4 and/or [Cc<1 or Cc>3.0] E		GP	Poorly graded gravel F
		Gravels with Fines: More than 12% fines C	Fines classify as ML or MH		GM	Silty gravel F, G, H
			Fines classify as CL or CH		GC	Clayey gravel F, G, H
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines D	Cu ³ 6 and 1 £ Cc £ 3 E		SW	Well-graded sand I
			Cu < 6 and/or [Cc<1 or Cc>3.0] E		SP	Poorly graded sand I
		Sands with Fines: More than 12% fines D	Fines classify as ML or MH		SM	Silty sand G, H, I
			Fines classify as CL or CH		SC	Clayey sand G, H, I
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots 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	< 0.75	OL	Organic clay K, L, M, N
			Liquid limit - not dried			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	< 0.75	OH	Organic clay K, L, M, P
			Liquid limit - not dried			Organic silt K, L, M, Q
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

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

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

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

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

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

F If soil contains ³ 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 ³ 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 ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

M If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

N PI ³ 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.