ENGINEERING GEOLOGY AND
GEOTECHNICAL ENGINEERING REPORT

FOR

PROPOSED REPLACEMENT HOME BLEACHERS,
HUENEME HIGH SCHOOL,
500 WEST BARD ROAD,
OXNARD, CALIFORNIA

PROJECT NO.: 303277-003
FEBRUARY 11, 2020

PREPARED FOR
OXNARD UNION HIGH SCHOOL DISTRICT

BY
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February 11, 2020

Project No.: 303277-003
Report No.: 20-2-33

Attention: Poul Hanson
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Project: Hueneme High School Home Bleachers
500 West Bard Road
Oxnard, California

As authorized, we have performed a geotechnical study for proposed replacement bleachers to be located on the campus of Hueneme High School in the City of Oxnard, California. The accompanying Engineering Geology and Geotechnical Engineering Report presents the results of our subsurface exploration and laboratory testing programs, as well as our conclusions and recommendations pertaining to geotechnical aspects of project design. This report completes the scope of services described within our Proposal No. VEN-19-12-013 dated December 19, 2019, and authorized by Purchase Order No. A20-02446 dated January 28, 2020.

We have appreciated the opportunity to be of service to you on this project. Please call if you have any questions, or if we can be of further service.

Respectfully submitted,

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INTRODUCTION

This report presents results of an Engineering Geology and Geotechnical Engineering study performed for proposed replacement bleachers to be located on the campus of Hueneme High School in the City of Oxnard, California. Although detailed plans are not available at this time, it is our understanding that the bleachers will have a footprint of 16,000 square feet and will replace the existing bleachers on the south (home) side of the existing football field.

The Hueneme High School campus is located at 500 West Bard Road in the City of Oxnard (see Vicinity Map in Appendix A). The bleachers will be located near the southern boundary of the campus. The coordinates of the existing home bleachers are 34.1573° north latitude and -119.1820° west longitude. The new bleachers will be in the same area as the existing bleachers. There are no springs or seeps on the property.

Based on interpretation of the USGS 7.5-Minute Oxnard Quadrangle, slope gradients near the site are about 0.29%, or 5 feet over 1,700 feet. Because the site is relatively flat grading for the proposed project is expected to be limited to preparing near-surface soils to support the new loads after removing the existing foundation system. Existing electrical lines may need to be relocated out of the proposed grading zone if they are located within or near the proposed footprint of the bleachers.

It is understood that bleachers of this type are generally supported by spread footings, but piers or some other structural configuration are sometimes required. Pad footings are reportedly spaced from 12 to 24 feet apart in the longitudinal direction and 14 to 15 feet in the traverse direction. According to Southern Bleachers, typical column loads are less than 50 kips, and this maximum load was used as a basis for the recommendations of this report. If actual loads vary significantly from these assumed loads, Earth Systems should be notified since reevaluation of the recommendations contained in this report may be required.

PURPOSE AND SCOPE OF WORK

The purpose of the geotechnical study that led to this report was to analyze the geology and soil conditions of the site with respect to the proposed improvements. These conditions include potential geohazards, surface and subsurface soil types, expansion potential, settlement potential, bearing capacity, and the presence or absence of subsurface water. The scope of work included:

1. Reconnaissance and geological mapping of the site.
2. Reviewing a pair of stereographic aerial photographs taken of the site and surrounding areas on October 25, 1945 by Fairchild Aerial Surveys, Inc.
3. Reviewing pertinent geologic and geotechnical literature, including reports for replacement bleachers that were prepared by Earth Systems in 2010.
4. Drilling, sampling, and logging a new mud rotary boring to supplement 2010 data and to study geologic, soil, and groundwater conditions.
5. Laboratory testing of soil samples obtained from the subsurface exploration to determine their physical and engineering properties.
6. Consulting with owner representatives and design professionals.
7. Analyzing the geotechnical data obtained from the new boring and from one boring and two cone penetrometer test (CPT) soundings our 2010 study.
8. Preparing this report.

Contained in this report are:

1. Descriptions and results of field and laboratory tests that were performed.
2. Discussions pertaining to the local geologic, soil, and groundwater conditions.
3. Conclusions pertaining to geohazards that could affect the site.
4. Conclusions and recommendations pertaining to site grading and structural design.

GEOLOGY

A. <u>Regional Geology</u>

The site lies within the Oxnard Plain, which in turn lies within the western Transverse Ranges geomorphic province. The Oxnard Plain and the Transverse Ranges are characterized by ongoing tectonic activity. In the vicinity of the subject site, Tertiary and Quaternary sediments have been folded and faulted along predominant east-west structural trends.

The Hueneme High School campus is not within any of the Fault Rupture Hazard Zones that have been delineated by the State of California, nor is it within any of the "Fault

Displacement Zones" delineated within the Ventura County General Plan Hazards Appendix (2013), or any of the fault-related Geologic Hazards delineated in the City of Oxnard Safety Element of the 2020 General Plan (1990). Although the surface trace of the Simi-Santa Rosa fault is the nearest fault of significance (i.e. “active” or “potentially active”) to the campus at 6.2 miles to the northeast, the Oak Ridge (Onshore) fault is considered the most critical. It is a south dipping reverse fault that generally parallels the south side of the Santa Clara River Valley, and at its closest position to the school site the surface trace is approximately 6.4 miles northwest of the campus. When considering the fault dips at about 65°, at depth the fault could be considered to be 5.8 miles from the fault plane at its nearest point.

The Hueneme High School campus is not located within any of the Seismic-Induced Landslide areas designated by the California Geological Survey (CGS, 2002b), but is within one of the Liquefaction Hazard Zones designated by CGS.

B. Stratigraphy

Bedrock was not encountered during the subsurface investigation, and it is anticipated that it is located at least several hundred feet below the existing ground surface. Natural earth materials underlying the subject site are alluvial deltaic sediments (Qal) consisting of relatively thinly interbedded loose to medium dense silty sands, fine to medium sands, sandy silts, and clays.

C. Structure

Bedding attitudes were not measured within the alluvial deposits, but it is considered likely that bedding is oriented nearly parallel to the natural ground surface.

No faults or landslides were observed to be located on or trending into the subject campus during the field study, during reviews of the referenced geologic literature, or during review of the aerial photographs taken of the site.

GEOLOGIC HAZARDS

Geologic hazards that may impact a site include seismic shaking, fault rupture, landsliding, liquefaction, seismic-induced settlement of dry sands, and flooding.

A. Seismic Shaking

1. Southern California is a seismically active region where the potential for significant ground shaking is universal. Earthquakes of a size large enough to cause structural damage are relatively common in the region. Per the State of California guidelines for these types of reports, when evaluating the seismicity potential of a specific site, it is general practice to look at the historical seismic record of the area and also review the site location with respect to mapped potentially active and active faults. By using this procedure, estimates of maximum ground accelerations are determined for consideration in structural design for buildings. The geotechnical community uses the method even though most are well aware of its shortcomings. The most significant shortcomings relate to the presence of unknown seismogenic faults well below the surface, and the amount of uncertainty regarding the time intervals between earthquake events on many of the recognized faults. The 1983 Coalinga and 1994 Northridge Earthquakes are examples of relatively large events that occurred on previously unrecognized faults. Man has only been using instruments to monitor earthquakes since the 1930's, which is a relatively short time span considering that the intervals between large earthquakes on some of the regional faults are on the order of thousands of years. Considering the above, an evaluation of site acceleration potential will lead to a value that must be considered an approximation. The structural designers must be aware that there are inherent uncertainties in the determined value or range.

2. The Oxnard area has not experienced any local large earthquakes since records have been kept; however, regional earthquakes have led to significant ground shaking and structural damage. Notable regional earthquakes include the 1812 Santa Barbara Channel and 1857 Fort Tejon events. The epicenter of the 1812 earthquake is thought to have been in the western part of the Santa Barbara channel. Associated with this earthquake, a tsunami with a disputed run up height of up to 15 feet impacted the Ventura coastal area. On January 9, 1857, the Fort Tejon earthquake with an estimated Richter magnitude of 8.25 impacted the region. According to C.D.M.G. (1975), the earthquake caused the roof of the Mission San Buenaventura to fall in.

3. One measure of ground shaking is intensity. The Modified Mercalli Intensity Scale of ground shaking ranges from I to XII with XII indicating the maximum possible intensity

of ground movement. Structural damage begins to occur when the intensity exceeds a value of VI. Southern Ventura County has been mapped by the California Division of Mines and Geology to delineate areas of varying predicted seismic response. The Alluvium that underlies the subject area is mapped as having a probable maximum intensity of earthquake response of approximately IX on the Modified Mercalli Scale. Historically, the highest estimated intensity in the Oxnard area has been VII (CDMG, 1975, 1994).

4. The school site, like any other site in the region, is subject to relatively severe ground shaking in the event of a maximum earthquake on a nearby fault. In Appendix A is a regional fault location map that shows the site's relationship to the identified faults in the region. In Appendix C is a summary table listing well-identified faults within a 37-mile radius of the school, the distance between each fault and the school, and mean earthquake magnitudes that could occur on each of the listed faults. A proprietary program utilizing the State of California's fault model (CGS and USGS, 2008) was used to prepare the list.

5. It is assumed that the 2019 CBC and ASCE 7-16 guidelines will apply for the seismic design parameters used in design. The 2019 CBC includes several seismic design parameters that are influenced by the geographic site location with respect to active and potentially active faults, and with respect to subsurface soil or rock conditions. The "general procedure" (i.e. probabilistic) seismic design parameters presented below were determined by the U.S. Seismic Design Maps "risk-targeted" calculator on the SEAOC/OSHPD website for ASCE 7-16 for the site coordinates (34.1573° North Latitude and 119.1820° West Longitude, Soil Site Class D (for stiff soils), for Occupancy (Risk) Category III (which includes public school projects). (A listing of the calculated 2019 CBC and ASCE 7-16 Seismic Parameters is presented below and again in Appendix C.)

Summary of Seismic Parameters – 2019 CBC "General Procedure"

Site Class (ASCE 7-16)	D
Occupancy (Risk) Category	III
Seismic Design Category	D
Maximum Considered Earthquake (MCE) Ground Motion	
Spectral Response Acceleration, Short Period – S_s	1.593 g
Spectral Response Acceleration at 1 sec. – S_1	0.584g
Site Coefficient – F_a	1.00
Site Coefficient – F_v	See CBC Section 11.4.8
Site-Modified Spectral Response Acceleration, Short Period – S_{MS}	1.593 g
Site-Modified Spectral Response Acceleration at 1 sec. – S_{M1}	See CBC Section 11.4.8
Design Earthquake Ground Motion	
Short Period Spectral Response – S_{DS}	1.062 g
One Second Spectral Response – S_{D1}	See CBC Section 11.4.8
Site Modified Peak Ground Acceleration - PGA_M	0.758 g
Values appropriate for a 2% probability of exceedance in 50 years	

If the structural engineer determines that ASCE 7-16, Section 11.4.8, Exception 2 does not apply, because the seismic factor S_1 is greater than 0.2 g and the Site Class is "D", a site-specific (i.e. deterministic) ground motion hazard analysis is required. The site-specific study takes into account soil amplification effects. The United States Geological Survey (USGS, 2009) has undertaken a probabilistic earthquake analyses that covers the continental United States. A reasonable site-specific spectral response curve may be developed from USGS Unified Hazard Tool web page, which adjusts for site-specific ground factors. The interactive webpage appears to be a precise calculation based on site coordinates. For the purposes of this study, the Dynamic: Conterminous U.S. 2014 (Update) (Version 4.20) values have been chosen for use in the analysis.

NGA West 2014 attenuation relationships were used in the analyses. These attenuations included those of Abrahamson, Silva and Kamai, Boore and Stewart, Campbell and Bozorgnia, Chiou and Youngs, and Idriss.

Summary of Seismic Parameters – 2019 CBC "Site-Specific Procedure"

Site Class (ASCE 7-16)	D
Occupancy (Risk) Category	III
Seismic Design Category	D
Maximum Considered Earthquake (MCE) Ground Motion	
Site Coefficient – F_a	1.00
Site Coefficient – F_v	2.50
Site-Modified Spectral Response Acceleration, Short Period – S_{MS}	1.640 g
Site-Modified Spectral Response Acceleration at 1 sec. – S_{M1}	1.313 g
Design Earthquake Ground Motion	
Short Period Spectral Response – S_{DS}	1.093 g
One Second Spectral Response – S_{D1}	0.875 g
Site Modified Peak Ground Acceleration - PGA_M	0.732 g
Values appropriate for a 2% probability of exceedance in 50 years	

6. California has had several large earthquakes in this century, and studies on the structural effects of the ground shaking have led to changes in the building codes. After the 1933 Long Beach Earthquake, the State of California Field Act was written with the intention of making public schools more earthquake resistant. The intent of the act, as is the intent of the most modern codes, is as follows: "School buildings constructed pursuant to these regulations are expected to resist earthquake forces generated by major earthquakes in California without catastrophic collapse, but may experience some repairable architectural or structural damage". Following the 1971 San Fernando Earthquake, many changes were made to the public school building codes. After the 1994 Northridge Earthquake, a study of 127 public schools in the Los Angeles area by the State of California Division of the State Architect (1994a) revealed that the intent of the Field Act was being met even when buildings were subjected to horizontal accelerations approaching 0.9 g (much higher than expected) over a large area. None of the schools collapsed and most of the damage that would have caused injury to students, had school been in session, was from failures of non-structural items such as light fixtures, florescent bulbs, suspended ceilings, etc. Most of the schools that experienced these non-structural failures were built before the changes

to the building code that applied to these non-structural items. The study also resulted in recommended changes to building codes regarding steel framed school buildings, (State of Calif. Div. of State Architect, 1994b).

B. Fault Rupture

Surficial displacement along a fault trace is known as fault rupture. Fault rupture typically occurs along previously existing fault traces. As mentioned in the "Structure" section above, no existing fault traces were observed to be crossing the site. As a result, it is the opinion of this firm that the potential for fault rupture on this site is low.

C. Landsliding and Rock Fall

As mentioned previously, the subject site is relatively flat. As a result, it appears that the hazards posed by landsliding and rock fall are nil.

D. Liquefaction, Cyclic Softening, and Lateral Spreading

As mentioned previously, the subject site is located within one of the Liquefaction Hazard Zones designated by CGS (2002b).

Earthquake-induced vibrations can be the cause of several significant phenomena, including liquefaction in fine sands and silty sands. Liquefaction results in a loss of strength and can cause structures to settle or even overturn if it occurs in the bearing zone. Liquefaction is typically limited to the upper 50 feet of soils underlying a site.

Fine sands and silty sands that are poorly graded and lie below the groundwater table are the soils most susceptible to liquefaction. Soils that have I_c values greater than 2.6, soils with plasticity indices greater than 7, sufficiently dense soils, and/or soils located above the groundwater table are not generally susceptible to liquefaction.

An examination of the conditions existing at the site, in relation to the criteria listed above, indicates the following:

1. Groundwater was encountered at a depth of approximately 12 feet in Boring B-1 drilled in 2009 and 10 feet in Boring B-5 drilled for this study. Interpolating between historically high groundwater levels mapped by the California Geological Survey (CGS, 2002a) indicates that groundwater has been 6.5 feet below the

ground surface near the subject site. For the liquefaction analyses, a groundwater depth of 6.5 feet below the ground surface was used.

2. The soil profile consists of interbedded stratum of non-plastic sands, silts and clays to the maximum depths explored.
3. Atterberg limit evaluations of two samples obtained from Boring B-1 during 2009 and from five samples obtained from Boring B-5 during this study indicate that the finer grained soils have Plasticity Indices (PI's) in the range of non-plastic to 30, and classify as ML, MH and CL. A sample taken from a depth of 45 feet in Boring B-5 was determined to be non-plastic and is expected to exhibit sand-like behavior during earthquake cyclic loading. The remaining fine-grained samples tested had PI's ranging from 8 to 30, so these soils are expected to exhibit clay-like behavior during earthquake cyclic loading.
4. Standard penetration tests conducted in the borings indicate that soils within the tested depth are in a variably dense state.

Based on the above, cyclic mobility analyses were undertaken to analyze the liquefaction and seismic-induced settlement potentials of the various soil layers. The liquefaction analyses were performed in general accordance with the methods proposed by NCEER (1997). In the analyses, the design earthquake was considered to be a 7.2 moment magnitude event, and the higher site modified peak ground acceleration (PGA_M) of 0.758 g was used, as per the discussion in the "Seismicity and Seismic Design" section of this report.

The analyses with groundwater at the historical high groundwater depth of 6.5 feet indicated that layers totaling about 18.5 feet in thickness in Boring B-1 and about 9 feet in thickness in Boring B-5 had factors of safety that were less than 1.3. Those zones with factors of safety less than 1.3 are considered potentially liquefiable (C.G.S., 2008, and SCEC, 1999).

The volumetric strain for the potentially liquefiable zones was estimated using a chart derived by Tokimatsu and Seed (1987) after reducing the N_160 values by the calculated "FC Delta" value, then making adjustments for fines content as per Seed (1987) and SCEC (1999). Using this methodology, the following volumetric strains were estimated:

Boring Number	Estimated Liquefaction-Induced Settlement (inches)
B-1	4.2
B-5	1.9

According to a chart derived by Ishihara (National Academy Press, 1985) using the corrected standard blow counts measured in the test borings, "ground" damage would not be expected related to the shallowest potentially liquefiable zones identified in the borings. (Examples of ground damage are sand boils and ground cracks.) C.D.M.G. states that Ishihara is not valid for sites with lateral spread or ground oscillation but is valid when these issues are not among the possibilities.

Although construction of a compacted engineered fill mat beneath the proposed home bleachers will mitigate the potential for ground damage, there is a potential for differential areal settlement suggested by the findings. As mentioned previously, the combined liquefaction and seismic-induced settlements could potentially range from 4.2 inches in Boring B-1 at the west end of the proposed bleachers to about 1.9 inches in Boring B-5 at the east end. According to SCEC (1999), up to about half of the total settlement could be realized as differential settlement. However, because more than one exploration point, located within about 375 feet of each other, was analyzed for liquefaction potential, the differential settlement was taken as the difference of the two borings, or about 2.3 inches. Based on the gradient of differential settlement change between the borings, Earth Systems estimates a differential settlement of 1.8 inches across the full length of the bleachers, or about ¼ inch over a horizontal distance of 30 feet. The equivalent angular distortion is 1/1,140.

To evaluate the potential for a bearing capacity failure, Earth Systems used the residual undrained shear strength of the liquefiable soil between the depths of about 6.5 and 13.5 feet below the ground surface in Boring B-1. The residual undrained shear strength of the liquefiable soil was estimated using the equivalent clean sand SPT blow count $(N_1)_{60\text{-}CS}$ within this liquefiable zone and the lower bound of the Seed & Harder (1990) plot. The lowest $(N_1)_{60\text{-}CS}$ for the liquefiable soils between the depths of about 6.5 and 13.5 feet is 13.3, with the average being 14.3. Using the lower bound of the Seed & Harder (1990) plot and a $(N_1)_{60\text{-}CS}$ of 13.3, the residual undrained shear strength of the upper liquefiable zone is about 280 psf. If the average value of $(N_1)_{60\text{-}CS}$ of 14.3 is used, the residual undrained shear strength of the liquefiable soils between the depths of about 6.5 and 13.5 feet is about 380 psf.

Based on a bearing pressure of 2,500 psf for isolated pad foundations, the stress at the top of the liquefiable zone at a depth of 6.5 feet below the ground surface for a 4.5-foot wide pad footing embedded 18 inches below finished grade is 750 psf. Based on a bearing pressure of 2,000 psf for continuous foundations, the stress at the top of the liquefiable zone at a depth of 6.5 feet below the ground surface for a 24-inch wide pad footing embedded 18 inches below finished grade is 400 psf. Given the lower bound residual undrained shear strength value of the liquefiable zone between 6.5 and 13.5 feet below the ground surface and the stress that will be imposed to the top of this layer, a bearing capacity failure would not be anticipated during a design seismic event, since the allowable bearing pressure in the liquefied soil is 1,500 psf for a continuous spread foundation and 2,000 psf for square pad footings. Both provide a factor of safety greater than 2.5 against bearing capacity failure.

”Free face” lateral spreading does not appear to pose a potential hazard because there are no nearby sloped areas or canyons (Bartlett and Youd, 1995). “Ground slope” lateral spreading, sometimes referred to as “ground oscillation”, can occur when adjusted blow counts ($N_{1(60)}$) measured within potentially liquefiable zones are less than 15, which is true for a 7-foot thick potentially liquefiable zone between the depths of 6.5 and 13.5 feet below the ground surface in Boring B-1 (2009). The cumulative thickness of this layer is about 2.13 meters. The potential ground oscillation was analyzed in accordance with procedures developed by Youd, Hansen and Bartlett (2002). In the analyses, it was assumed that the surface slope was 0.29%, which is equivalent to about 5 feet of fall in 1,700 feet, as shown on the Oxnard Quadrangle near the subject site. Fine contents were estimated to be 52% based on laboratory testing on soil samples within this zone. The cumulative displacement was calculated to be about 0.31 feet (3.7 inches), if all of these potentially liquefiable zones were to liquefy. A 3.5-foot thick potentially liquefiable zone with a ($N_{1(60)}$) value less than 15 was encountered in Boring B-5 between the depths of 36.5 and 40 feet below the ground surface. Fine contents were estimated to be 64% based on laboratory testing on soil samples within this zone. The cumulative displacement was calculated to be about 0.10 feet (1.2 inches). (Calculations are included within Appendix E of this report.)

Based on the above, it is the opinion of this firm that a potential for liquefaction exists at the proposed home bleachers site. Because minor horizontal displacements due to lateral spreading (i.e., less than 4 inches) were calculated, the potential for movements from lateral spreading capable of adversely affecting the structural integrity of the steel-frame bleacher structure is considered to be low.

E. Seismic-Induced Settlement of Dry Sands

Sands tend to settle and densify when subjected to earthquake shaking. The amount of settlement is a function of relative density, cyclic shear strain magnitude, and the number of strain cycles. A procedure to evaluate this type of settlement was developed by Seed and Silver (1972) and later modified by Pyke, et al (1975). Tokimatsu and Seed (1987) presented a simplified procedure that has been reduced to a series of equations by Pradel (1998).

Calculations for Borings B-1 and B-5 indicate the potential for seismically-induced settlement of sands located above the groundwater table to be low (less than 0.1 inch). Construction of a compacted engineered fill mat beneath the proposed home bleachers will mitigate the seismically-induced settlement of dry sands.

F. Flooding

Earthquake-induced flooding types include tsunamis, seiches, and reservoir failure. The site is not near any lakes; thus, hazard posed by seiches is nil. The site is not located within the tsunami inundation zone delineated by CEMA, et al. (2009), or within the tsunami inundation zone delineated in the City of Oxnard 2020 General Plan (1990). Thus, the potential hazard posed by tsunamis is low.

According to the Ventura County General Plan Hazards Appendix (2013), this site, like most of the Oxnard Plain, is within a dam failure inundation zone for Lake Castaic, Pyramid Lake, Lake Piru, and Bouquet Canyon Dam. Proper maintenance of these dams is anticipated, and assuming the maintenance continues as planned, the hazard posed by reservoir failure appears to be low.

The site is within an area mapped within Zone X (F.E.M.A., 2020). Zone X is defined as: "Area of minimal flood hazard". From this, it appears that the hazard posed by storm-induced flooding is low.

SOIL CONDITIONS

Evaluation of the subsurface indicates that soils are generally discontinuous, interbedded strata of alluvial sands, silty sands, silty to sandy clays, and sandy to clayey silts. Near-surface soils encountered below the fields are characterized by low blow counts and in-place densities, and moderate compressibilities. Testing indicates that anticipated bearing soils lie in the "very low" expansion range because the expansion index equals 6. [A version of this classification of soil expansion, Table 18-I-D, is included in Appendix B of this report.] It appears that soils can be cut by normal grading equipment.

Groundwater was encountered at a depth of 12 feet on December 23, 2009 in Boring B-1, and at a depth of 10 feet in Boring B-5 on January 13, 2020. Mapping of historically high groundwater levels by the California Geological Survey (CGS, 2002a) indicates that groundwater has been 6.5 feet below the ground surface near the subject site.

Samples of near-surface soils were tested for pH, resistivity, soluble sulfates, and soluble chlorides. The test results provided in Appendix B should be distributed to the design team for their interpretations pertaining to the corrosivity or reactivity of various construction materials (such as concrete and piping) with the soils. It should be noted that sulfate contents, ranging from 21 to 1,500 mg/Kg) are in the "S0" (negligible) to "S1" ("moderate") exposure class of Table 19.3.1.1 of ACI 318-14. Because of the variability, it is recommended that special concrete designs be used for the measured sulfate contents. In accordance with Table 19.3.2.1 of ACI-318 14, the concrete should have Type II Portland cement, a maximum water-cement ratio of 0.50, and a minimum 28-day compressive strength of 4,000 psi.

Measurements of resistivity of near-surface soils ranged from 860 ohms-cm to 6,100 ohms-cm. Criteria established by the County of Los Angeles (2013) classifies these soils as ranging from "severely corrosive" to "moderately corrosive" to ferrous metals (i.e. cast iron, etc.) pipes.

GEOTECHNICAL ENGINEERING
CONCLUSIONS AND RECOMMENDATIONS

The site is suitable for the proposed development from Engineering Geology and Geotechnical Engineering standpoints provided that the recommendations contained in this report are successfully implemented into the project.

Mitigation of the potential effects of the design seismic event, including potential differential settlements ranging up to about 1.8 inches will be required. Recommendations are provided in the "Rough Grading/Areas of Development" and "Conventional Foundations" sections below that include the use of a compacted engineered fill mat with a structurally-enhanced conventional foundation.

To mitigate the anticipated liquefaction-related effects, Earth Systems recommends that a geogrid reinforced gravel raft be constructed beneath the bleacher. The intent of the geogrid reinforced gravel raft is to stiffen underlying soils so that they act as a block that would result in more uniform settlement beneath the structure and mitigate the potential for a bearing capacity failure.

A. <u>Grading</u>

1. <u>Pre-Grading Considerations</u>
   a. Plans and specifications should be provided to Earth Systems prior to grading. Plans should include the grading plans, foundation plans, and foundation details.
   b. Final site grade should be designed so that all water is diverted away from the structures over paved surfaces, or over landscaped surfaces in accordance with current codes. Water should not be allowed to pond anywhere on the pad.
   c. Shrinkage of soils affected by compaction is estimated to be about 10 percent based on a relative compaction of 92 percent of the maximum dry density. Shrinkage from removal of the existing foundation system and/or any underground structures is not included in these figures.
   d. It is recommended that Earth Systems be retained to provide Geotechnical Engineering services during site development and grading, and foundation construction phases of the work to observe compliance with the design concepts, specifications and recommendations, and to allow design changes in

the event that subsurface conditions differ from those anticipated prior to the start of construction.

e. Compaction tests shall be made to determine the relative compaction of the fills in accordance with the following minimum guidelines: one test for each two-foot vertical lift; one test for each 1,000 cubic yards of material placed; and four tests at finished subgrade elevation within the pad.

2. Rough Grading/Areas of Development

a. Grading at a minimum should conform to the 2019 California Building Code.

b. The existing ground surface should be initially prepared for grading by removing the existing bleachers structure, including all foundation elements and concrete flatwork. Following removal of the existing bleachers and concrete from within the work area, the resulting ground surface beneath the existing bleachers should be cleared of all vegetation, trash, and unsuitable materials. Organics and debris should be stockpiled away from areas to be graded, and ultimately removed from the site to prevent their inclusion in fills. Because of the remedial grading recommended, voids created by removal of such material will be backfilled during remedial grading. No compacted fill should be placed unless the underlying soil has been observed by the Geotechnical Engineer.

c. To minimize the propagation of liquefaction-induced ground damage to the proposed bleachers, and to minimize differential settlements and lateral spreading effects, native soils throughout the proposed bleacher footprint should be excavated a minimum of 5 feet below existing grade or 3.5 feet below the bottom of the foundation, whichever is deeper. Structural plans and details should be checked carefully during grading to establish the actual foundation bottom elevations in the field. Overexcavation should be extended laterally to a distance of at least 5 feet laterally beyond the outside edge of the foundation footprint. The bottom of the overexcavation should be relatively level, and stable. The bottom of the remedial excavation should be scarified to a depth of 6 inches, uniformly moisture conditioned to above the optimum moisture content, and compacted to achieve a relative compaction of 90 percent of the ASTM D 1557 maximum dry density. Compaction of the prepared subgrade should be verified by testing prior to the placement of engineered fill.

d. On-site soils may be used for fill once they are cleaned of all organic material, rock, debris and irreducible material larger than 8 inches.

e. Fill and backfill placed above the optimum moisture content in layers with loose thickness not greater than 8 inches should be compacted to a minimum of 90 percent of the maximum dry density obtainable by the ASTM D 1557 test method.

3. Utility Trenches

a. Utility trench backfill should be governed by the provisions of this report relating to minimum compaction standards. In general, on-site service lines may be backfilled with native soils compacted to 90 percent of the maximum density. Backfill of offsite service lines will be subject to the specifications of the jurisdictional agency or this report, whichever are greater.

b. Utility trenches running parallel to footings should be located at least 5 feet outside the footing line, or above a 2:1 (horizontal to vertical) projection downward from 9 inches above the bottom of the outside edge of the footing.

c. Compacted native soils should be utilized for backfill below structures. Sand should not be used under structures because it provides a conduit for water to migrate under foundations.

d. Backfill operations should be observed and tested by the Geotechnical Engineer to monitor compliance with these recommendations.

B. Structural Design

1. Conventional Foundations with Compacted engineered fill mat

a. Conventional spread footings may be used to support the proposed home bleachers provided a compacted fill mat is constructed beneath the structure. Pad footings must be tied together by grade beams (each way), and grade beams should also extend from pads to adjacent perimeter footings. The intent of the grade beams is to provide additional stiffness to the foundation to help mitigate potential liquefaction-related effects. Footings should have a minimum embedment depth of 18 inches.

b. Footings should bear into firm recompacted soils, as recommended elsewhere in this report. Foundation excavations should be observed by a representative of this firm after excavation, but prior to placing of reinforcing steel or concrete, to verify bearing conditions.

c. Conventional continuous footings with a minimum width of 2 feet may be designed based on an allowable bearing value of 2,000 psf. This value is based on a factor of safety of at least 3.

d. Isolated pad footings with a minimum width of 4.5 feet may be designed based on an allowable bearing value of 2,500 psf. This value is based on a factor of safety of 3.

e. Allowable bearing values are net (weight of footing and soil surcharge may be neglected) and are applicable for dead plus reasonable live loads.

f. A one-third increase is permitted for use with the alternative load combinations given in Section 1605.3.2 of the 2019 CBC.

g. Lateral loads may be resisted by soil friction on floor slabs and foundations and by passive resistance of the soils acting on foundation stem walls. Lateral capacity is based on the assumption that any required backfill adjacent to foundations and grade beams is properly compacted.

h. Continuous footings bottomed in soils in the “very low” expansion range should be reinforced, at a minimum, with one No. 4 bar along the bottom and one No. 4 bar along the top.

j. Bearing soils in the “very low” expansion range should be premoistened prior to placing concrete, but testing of premoistening will not be required.

2. Frictional and Lateral Coefficients

a. Resistance to lateral loading may be provided by friction acting on the base of foundations. For foundations supported in compacted engineered fill, a coefficient of friction of 0.62 may be applied to dead load forces. This value does not include a factor of safety.

b. For foundations supported in compacted engineered fill, passive resistance acting on the sides of foundation stems equal to 390 pcf of equivalent fluid weight may be included for resistance to lateral load. This value does not include a factor of safety.

c. A minimum factor of safety of 1.5 should be used when designing for sliding or overturning.

d. For the foundations, passive resistance may be combined with frictional resistance provided that a one-third reduction in the coefficient of friction is used.

3. Settlement Considerations
   a. In the event of a strong seismic event, the soils underlying the site could undergo a liquefaction-related settlement of about 2 inches at the east end and about 4 inches at the west end.
   b. The potential for seismically-induced settlement of dry sands above the groundwater level at the site is low, and construction of the geogrid reinforced gravel raft should mitigate this problem.
   c. Based on the gradient of differential settlement change between the borings, Earth Systems estimates a differential settlement of 1.8 inches across the full length of the bleachers, or about ¼ inch over a horizontal distance of 30 feet.
   d. Maximum total static settlements of about one half of an inch (1/2”) are anticipated for conventional foundations designed as recommended.
   e. Differential static settlement between adjacent load bearing members should be less than one-half the total settlement, i.e. about one quarter of an inch (1/4”)
   f. The use of the recommended geogrid-reinforced pad with stiffened conventional foundation system will help to reduce the differential settlements, but will not eliminate or completely mitigate them.

ADDITIONAL SERVICES

This report is based on the assumption that an adequate program of monitoring and testing will be performed by Earth Systems during construction to check compliance with the recommendations given in this report. The recommended tests and observations include, but are not necessarily limited to the following:

1. Review of the building and grading plans during the design phase of the project.
2. Observation and testing during site preparation, grading, placing of engineered fill, and foundation construction.
3. Consultation as required during construction.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

The analysis and recommendations submitted in this report are based in part upon the data obtained from the borings and CPT soundings advanced into the subsurface of the site. The nature and extent of variations between and beyond the borings and soundings may not become evident until construction. If variations then appear evident, it will be necessary to reevaluate the recommendations of this report.

The scope of services did not include any environmental assessment or investigation for the presence or absence of wetlands, hazardous or toxic materials in the soil, surface water, groundwater or air, on, below, or around this site. Any statements in this report or on the soil boring logs regarding odors noted, unusual or suspicious items or conditions observed, are strictly for the information of the client.

Findings of this report are valid as of this date; however, changes in conditions of a property can occur with passage of time whether they be due to natural processes or works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur whether they result from legislation or broadening of knowledge. Accordingly, findings of this report may be invalidated wholly or partially by changes outside the control of this firm. Therefore, this report is subject to review and should not be relied upon after a period of one year.

In the event that any changes in the nature, design, or location of the improvements are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing.

This report is issued with the understanding that it is the responsibility of the Owner, or of his representative to ensure that the information and recommendations contained herein are called to the attention of the Architect and Engineers for the project and incorporated into the plan and that the necessary steps are taken to see that the Contractor and Subcontractors carry out such recommendations in the field.

As the Geotechnical Engineers for this project, Earth Systems has striven to provide services in accordance with generally accepted geotechnical engineering practices in this community at this time. No warranty or guarantee is expressed or implied. This report was prepared for the exclusive use of the Client for the purposes stated in this document for the referenced project only. No third party may use or rely on this report without express written authorization from Earth Systems for such use or reliance.

It is recommended that Earth Systems be provided the opportunity for a general review of final design and specifications in order that earthwork and foundation recommendations may be properly interpreted and implemented in the design and specifications. If Earth Systems is not accorded the privilege of making this recommended review, it can assume no responsibility for misinterpretation of the recommendations.

AERIAL PHOTOGRAPHS REVIEWED

Fairchild Aerial Surveys, October 25, 1945, Frame Nos. 9800-3-327 & 328, Scale 1:20,000.

SITE-SPECIFIC BIBLIOGRAPHY

Earth Systems Southern California, January 29, 2010, Geotechnical Engineering Report for Proposed Visitors' Bleachers, Hueneme High School, Oxnard, California (Job No.: VT-23434-03).

GENERAL BIBLIOGRAPHY

Abrahamson, N.A., and Silva, W.J., 1997, Empirical Response Spectral Attenuation Relations for Shallow Crustal Earthquakes: Seismological Research Letters.

Abrahamson, N.A., Silva, W.J, and Kamai, R., 2014, Summary of the ASK14 Ground Motion Relation for Active Crustal Regions,

Bartlett & Youd, 1995, Empirical Prediction of Liquefaction-Induced Lateral Spread, Journal of Geotechnical Engineering, April, 1995.

Boatwright, John, 1994, Modeling Ground Motions in the Near-Field of Rupturing Faults.

Boore, D.M., and Joyner, W.B., 1994, Prediction of Ground Motion in North America.

Boore, D.M., Joyner, W.B., and Fumal, T.E., 1997, Equations for Estimating Horizontal Response Spectra and Peak Acceleration from Western North America Earthquakes: A Summary of Recent Work.

Boore, D.M., Stewart, J.P., Seyhand, E., and Atkinson, G., 2014, NGA-West 2 Equations for Predicting PGA, PGV, nd5% Damped PGA for Shallow Crustal Earthquakes.

Borcherdt, Roger D., 1994, Estimates of Site-Dependent Response Spectra for Design (Methodology and Justification).

California Building Standards Commission, 2019, California Building Code, California Code of Regulations Title 24.

California Division of Mines and Geology (CDMG), 1954, Geology of Southern California, Bulletin 170, Geologic Guide No. 2 Ventura Basin.

CDMG, 1972, Fault Rupture Hazard Zones in California, Special Publication 42.

CDMG, 1973, Geology and Mineral Resources of Southern Ventura County, California.

CDMG, 1975, Seismic Hazards Study of Ventura County, California.

CDMG, 1995, The Northridge California Earthquake of 17 January, 1994, Special Publication 116.

CDMG., 1997, Guidelines for Evaluating and Mitigating Seismic Hazards in California, Special Publication 117.

CDMG, 1998, Maps of Known Active Fault Near-Source Zones in California and Adjacent Portions of Nevada.

California Emergency Management Agency (Cal EMA), February 15, 2009, Tsunami Inundation Map for Emergency Planning, State of California – County of Ventura, Oxnard Quadrangle.

California Geological Survey (CGS), 2002a, Seismic Hazard Zone Report for the Oxnard 7.5-Minute Quadrangle, Ventura County, California, Seismic Hazard Zone Report 052.

CGS, 2002b, Seismic Hazard Zones Map of the Oxnard 7.5-Minute Quadrangle.

CGS, 2008, Guidelines for Evaluating and Mitigating Seismic Hazards in California, Special Publication 117A.

Campbell, K.W., and Bozorgnia, Y., 2014, NGA-West2 Ground Motion Model for the Average Horizontal Componenets of PGA, PGV and 5% Damped Linear Acceleration Response Spectra.

Cetin, K.O., Seed, R.B., Der Kiureghian, A., Tokimatsu, K. Harder, L.F., Kayen, R.E., and Moss, R.E.S., 2004, Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential: ASCE Journal of Geotechnical and Geoenvironmental Engineering, v. 130, n. 12, p. 1314-1340.

Chiou, B.S-J, and Youngs, R.R., 2014, Update of the Chiou and Youngs NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra.

City of Oxnard, November 1990, City of Oxnard 2020 General Plan Safety Element.

Clahan, Kevin B., 2003, Geologic Map of the Oxnard 7.5' Quadrangle, Ventura County, California: A Digital Database, Version 1.0, U.S.G.S., S.C.A.M.P., and C.G.S. Map.

County of Los Angeles Department of Public Works, July 2013, Manual for Preparation of Geotechnical Reports.

Crowell, John C., 1975, San Andreas Fault in Southern California, C.D.M.G. Special Report 118.

Donnellan, A. Hager, B.H., and King, R.W., 1993, Rapid North-South Shortening of the Ventura Basin, Southern California.

Federal Emergency Management Agency (FEMA), 2020, Flood Map Service Center Website.

Hauksson Egill, Jones, Lucille M., and Hutton, Kate, 1995, The 1994 Northridge Earthquake Sequence in California.

Heaton, T.H., and Hartzell, S.H., 1994, Earthquake Ground Motions in the Near Source Region.

Huftile, Gary J., and Yeats, Robert S., 1995, Convergence Rates Across a Displacement Transfer Zone in the Western Transverse Ranges, Ventura Basin, California.

Idriss, I.M., and Boulanger, R.W., 2004, Semi-empirical procedures for evaluation liquefaction potential during earthquakes: Proceedings of the 11th SDEE and 3rd ICEGE, University of California, Berkeley, January 2004, plenary session, p. 32-56.

Idriss, I.M., and Boulanger, R.W., 2008, Soil liquefaction during earthquakes, Earthquake Engineering Research Institute, MNO-12.

Idriss, I.M., 2014, An NGA-West2 Empirical Model for Estimating the Horizontal Spectral Values Generated by Shallow Crustal Earthquakes.

Ishihara, K., 1985, Stability of Natural Deposits during Earthquakes, Proceedings of the International Conference on Soil Mechanics and Foundation Engineering.

Jennings, C.W., and W.A. Bryant, 2010, Fault Activity Map of California, Scale 1:750,000, CGS Geologic Data Map No. 6.

Kramer, Steven L., 1996, Geotechnical Earthquake Engineering.

Lajoie, Kenneth R., Sarna-Wojcicki, A.M., and Yerkes, R.F., 1982, Quaternary Chronology and Rates of Crustal Deformation in the Ventura area, California.

NCEER, 1997, Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils, Technical Report NCEER-97-0022.

Petersen, Mark D., and Wesnousky, S.D., 1994, Fault Slip Rates and Earthquake Histories for Active Faults in Southern California.

Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, Journal of Geotechnical and Geoenvironmental Engineering, ASCE, Vol. 124, No. 4, April.

Pyke, R., Seed, H. B., and Chan, C. K., 1975, Settlement of Sands Under Multidirectional Shaking, ASCE, Journal of Geotechnical Engineering, Vol. 101, No. 4, April, 1975.

Sadigh, K., Chang, C.Y., Egan, J.A., Madisi, F., and Youngs, R.R., 1997, Attenuation Relations for Shallow Crustal Earthquakes Based on California Strong Motion Data. Seismological Research Letters, Vol. 68, No. 1, pp 180-189.

Sarna-Wojcicki, A.M., K.M. Williams and R.F. Yerkes, 1976, Geology of the Ventura Fault, Ventura County, California, U.S.G.S. Miscellaneous Field Studies Map MF-781.

Seed, H. B., and Silver, M. L., 1972, Settlement of Dry Sands During Earthquakes, ASCE, Journal of Geotechnical Engineering, Vol. 98, No. 4, April, 1972.

Seed, R.B., Bray, J.D., Chang, S.W., and Dickensen, S.E., 1997, Site-Dependent Seismic Response Including Recent Strong Motion Data.

Seed, R.B., Cetin, K.O., Moss, R.E. S., Kammerer, A.M., Wu, J., Pestana, J.M., Riemer, M.F., Sancio, R.B., Bray, H.D., Kayen R.E., and Faris, A., 2003, Recent Advances in Soil Liquefaction Engineering,: A Unified and Consistent Framework: University of California, Earthquake Engineering Research Center Report 2003-06, 71p.

Shakal, A.F., Huang, M.J., Darragh, R.B., Cao, T., Sherburne, R.W., Malhotra, P., Cramer, C.H., Sydnor, R.H., Graizer V., Maldonado, G., Petersen, C., and Wampole, J., 1994, CSMIP Strong-Motion Records from the Northridge, California Earthquake of 17 January 1994.

Shaw, John H., and Suppe, John, 1994, Active Faulting and Growth Folding in the Eastern Santa Barbara Channel, California.

Sieh, Kerry E., 1978, Earthquake Intervals, San Andreas Fault, Palmdale, California, CDMG California Geology, June 1978.

Southern California Earthquake Center (SCEC), 1999, Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California.

Southern California Earthquake Center (SCEC), 2002, Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Landslide Hazards in California.

State of California Division of the State Architect Office of Regulation Services, May 1994, Northridge Earthquake (January 17, 1994) Performance of Public School Buildings.

State of California Division of the State Architect Office of Regulation Services, May 1994, Implementation of Northridge Earthquake Interim Guidelines for Steel Moment Frames.

Tokimatsu, K., and Seed, H. B., 1987, Evaluation of Settlements in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering-August 1987.

United States Geological Survey (USGS) 1989, Map Showing Late Quaternary Faults and 1978-1984 Seismicity of the Los Angeles Region, California. Map MF-1964.

USGS, 2017, U.S. Unified Hazard Tool Website.

Ventura County Planning Department, October 22, 2013, Ventura County General Plan Hazards Appendix.

Ventura County Planning Department, 1994, Ventura County Fault and Flood Hazards Map, Saticoy 7.5 Minute Quadrangle.

Ventura County Public Works Agency, Flood Control and Water Resources Agency, 1984, Report of Hydrologic Data 1981-1984.

Weber, F. Harold, Jr. and others, 1973, Geology and Mineral Resources of Southern Ventura County, California, C.D.M.G., Preliminary Report 14.

Wills, C.J., and Silva, W.S., 1998, Shear Wave Velocity Characteristics of Geologic Units in California.

Yeats, R.S., 1982 Low-Shake Faults of the Ventura Basin, California, in Cooper, J.D. compiler, Volume and Guidebook, Neotectonics in Southern California.

Yeats, Robert S., 1983, Large-Scale Quaternary Detachments in the Ventura Basin, Southern California.

Yeats, Robert S., Huftile, Gary J., and Grigsby, F.B., 1988, Oak Ridge Fault, Ventura Fold Belt, and the Sisar Decollement, Ventura Basin, California.

Yerkes, Robert F., and Lee. W.H.K., 1987, Late Quaternary Deformation in the Western Transverse Ranges.

Yerkes, R.F., Sarna-Wojcicki, A.M., and Lajoie, K.R., 1987, Geology and Quaternary Deformation of the Ventura Area, in Recent Faulting in the Transverse Ranges, California. USGS Professional Paper 1339.

Youd, T.L. and Garris, C.T., 1995, Liquefaction-Induced Ground-Surface Disruption: ASCE Journal of Geotechnical Engineering, v 121, n. 11, p. 805-809.

Youd, T.L., and Idriss, I.M., and 19 others, 2001, Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils: ASCE Geotechnical and Geoenvironmental Journal, v. 127, n. 10, p 817-833.

Youd, T.L., C.M. Hansen, and S.F. Bartlett, 2002, Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement, in Journal of Geotechnical and Geoenvironmental Engineering, December 2002.

APPENDIX A

Vicinity Map

Regional Fault Map

Regional Geologic Map

Seismic Hazard Zones Map

Historical High Groundwater Map

Field Study

Site Plan/Geologic Map

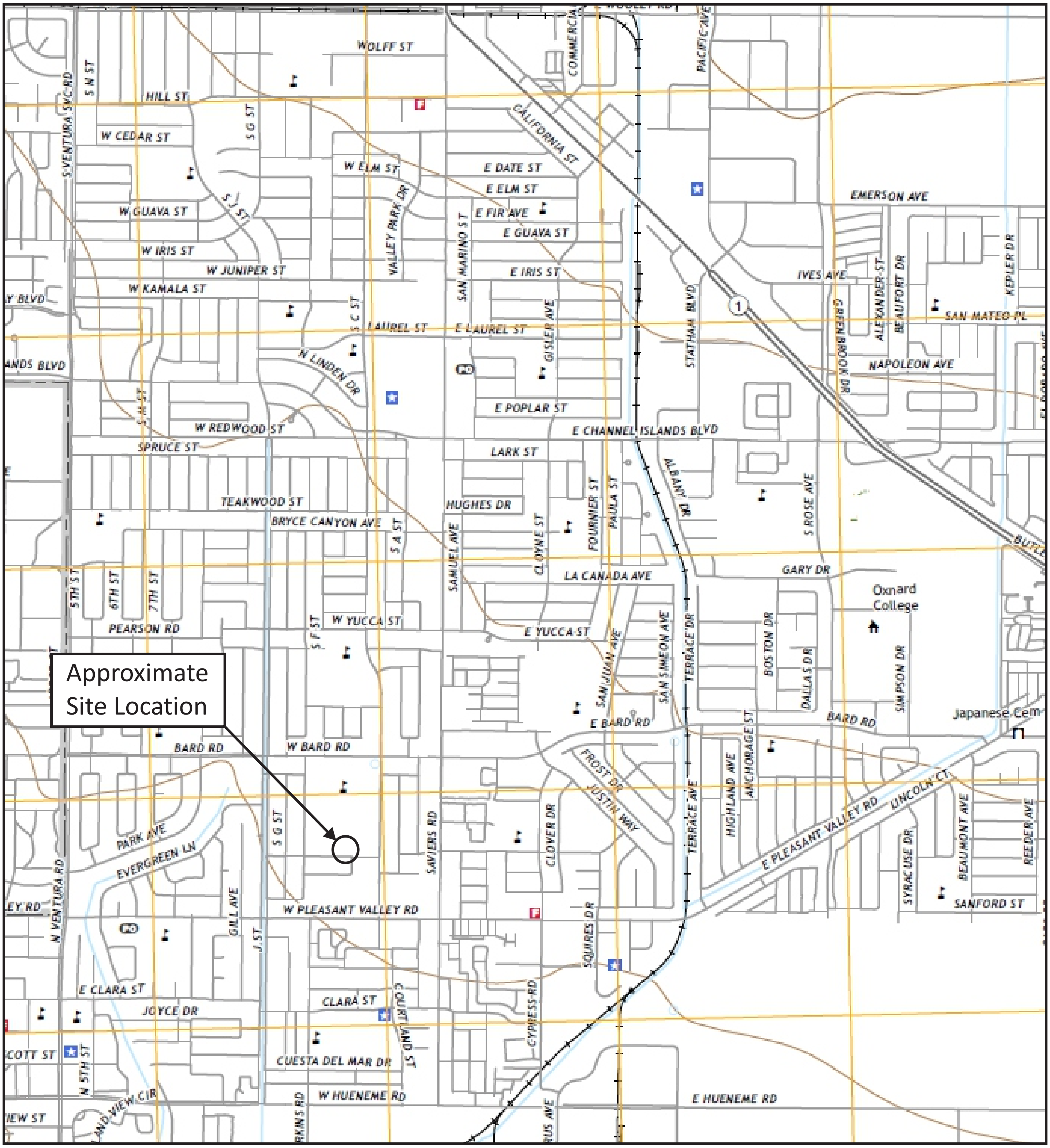
Geologic Cross-Section

Logs of Borings B-1 (2009) and B-5 (2020)

Logs and Interpretations of CPT Soundings (2009)

Boring Log Symbols

Unified Soil Classification System



*Taken from USGS Topo Map, Oxnard Quadrangle, California, 2018.

Approximate Scale: 1" = 2,000’

0 2,000’ 4,000’

N

VICINITY MAP

Hueneme High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303277-003

*Taken from Jennings and Bryant, Geologic Data Map No.6, 2010

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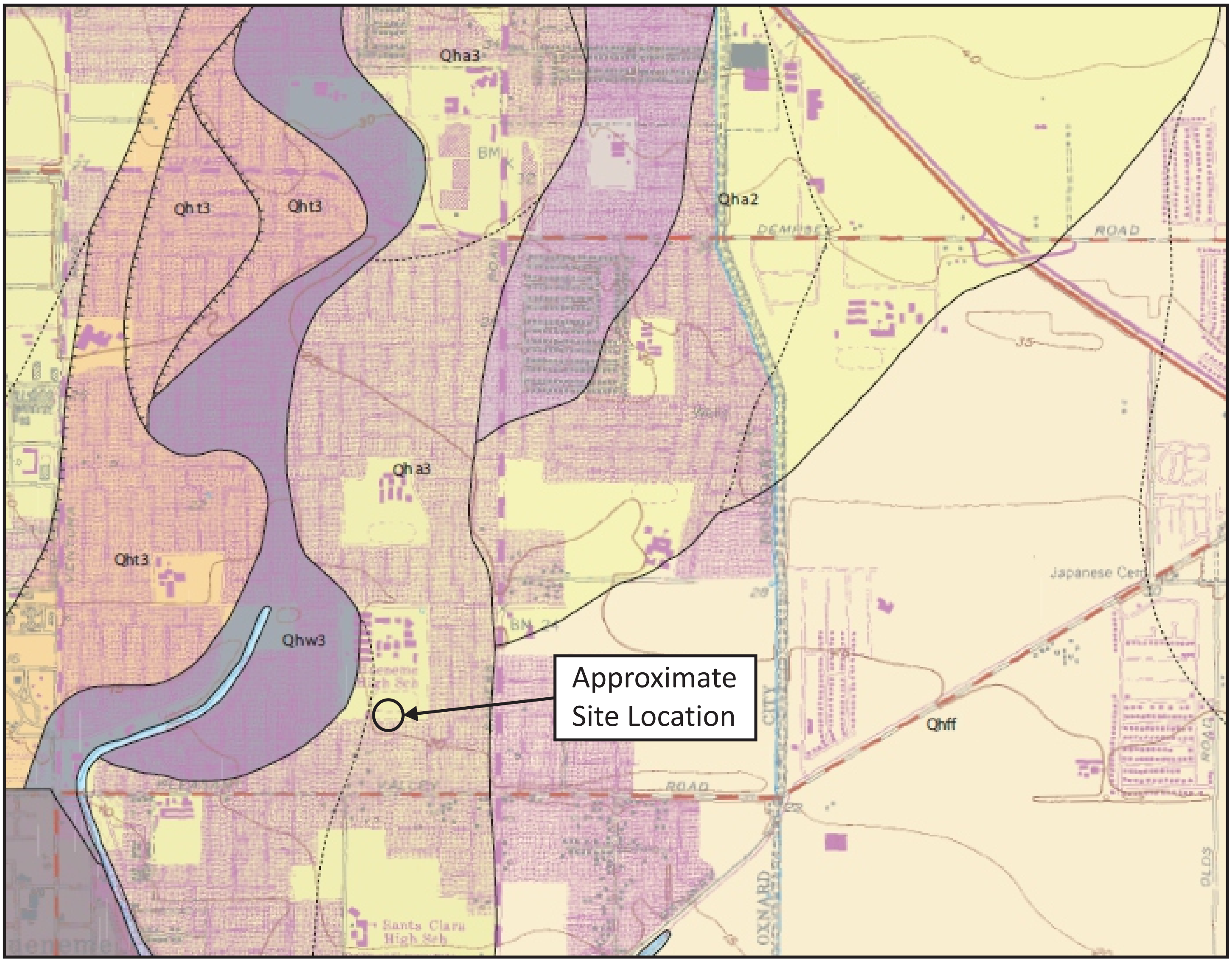
Approximate Scale:
1 Inch = 2 Mile

REGIONAL FAULT MAP	
Hueneme High School Home Bleachers Oxnard, California	
Earth Systems	
February 2020	303277-003



*Taken from USGS, SCAMP Geologic Map of the Ventura 7.5' Quadrangle, Ventura County, California, 2003.

Approximate Scale: 1" = 2,000'

0 2,000' 4,000'

N

MAP SYMBOLS

Contact between map units of different relative age; generally approximately located.

Contact between terraced alluvial units; hachures point towards topographically lower surface.

Contact between similar map units; generally approximately located.

Fault; dotted where concealed.

Axis of anticline; dotted where concealed.

Axis of syncline; dotted where concealed.

Qha3: Holocene alluvial deposits

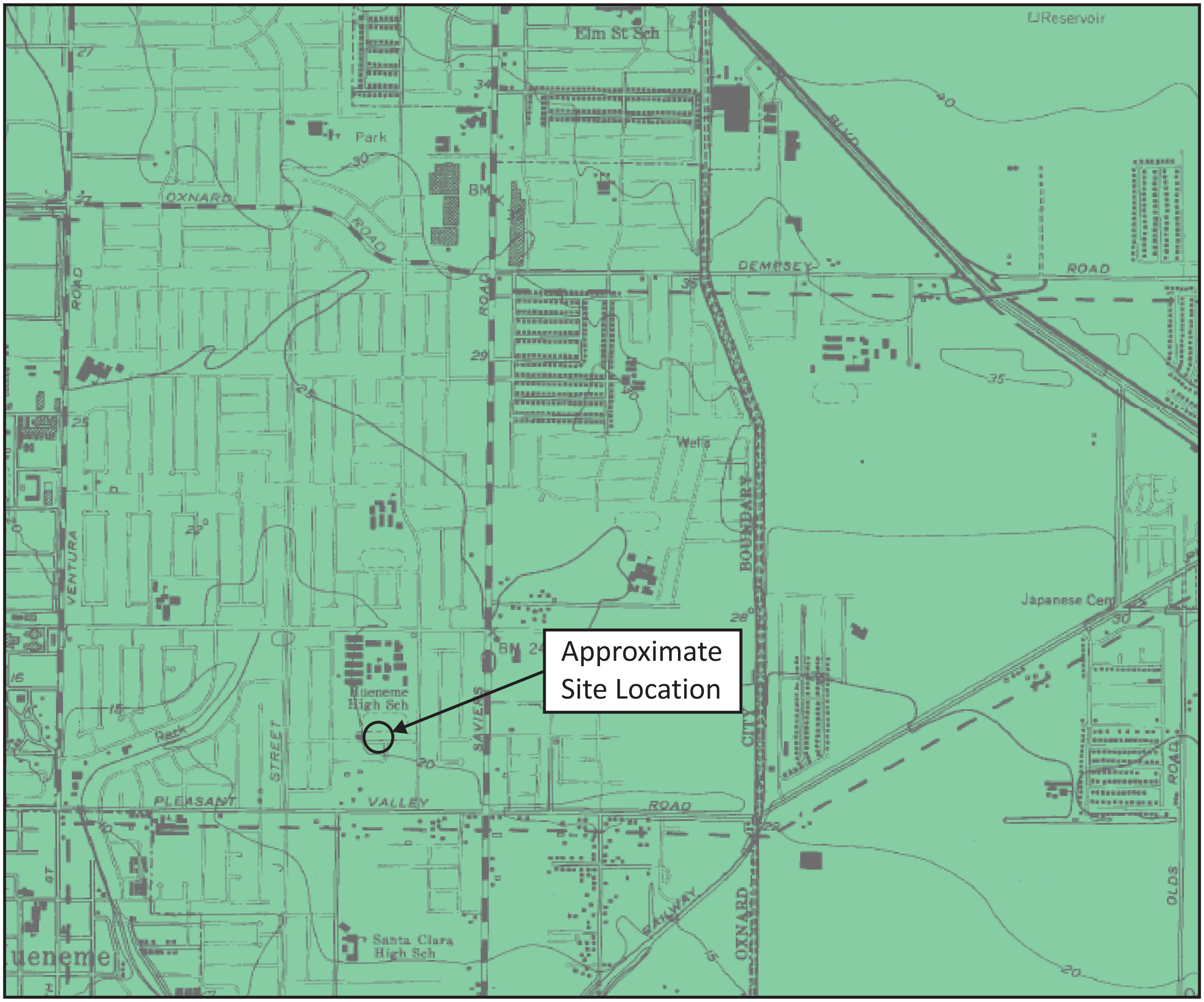
Qhw3: Holocene wash deposit

REGIONAL GEOLOGIC MAP

Hueneme High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303277-003



MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground-water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Within the Oxnard Quadrangle, no areas have been designated as "zones of required investigation for earthquake-induced landslides." However, the potential for landslides may exist locally, particularly along stream banks, margins of drainage channels, and similar settings where steep banks or slopes occur. Such occurrences are of limited lateral extent, or are too small and discontinuous to be depicted at 1:24,000 scale (the scale of Seismic Hazard Zone Maps). Within the liquefaction zones, some geologic settings may be susceptible to lateral-spreading (a condition wherein low-angle landsliding is associated with liquefaction). Also, landslide hazards can be created during excavation and grading unless appropriate techniques are used.

NOTE: Seismic Hazard Zones identified on this map may include developed land where delineated hazards have already been mitigated to city or county standards. Check with your local building/planning department for information regarding the location of such mitigated areas.

Approximate Scale: 1" = 2,000’

0 2,000’ 4,000’

STATE OF CALIFORNIA

SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

OXNARD QUADRANGLE

REVISED OFFICIAL MAP

Released: December 20, 2002

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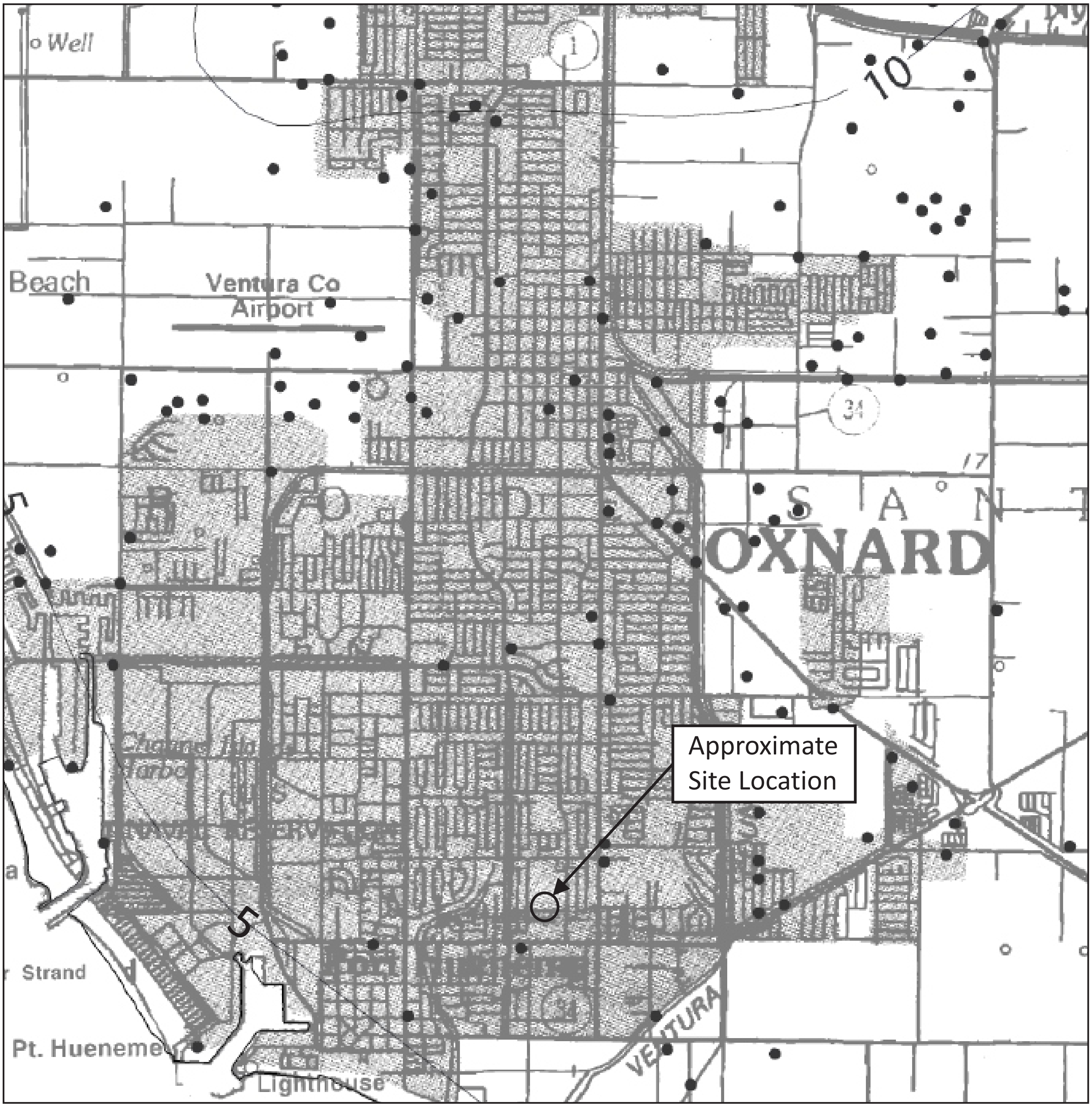
SEISMIC HAZARD ZONES MAP

Hueneme High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303277-003



*Taken from CGS, Seismic Hazard Zone Report For The Oxnard 7.5-Minute Quadrangle, Ventura County, California, 2003.

Symbol	Meaning
30 (contour line)	Depth to ground water in feet
●	Borehole Site

Approximate Scale: 1" = 4,000’

0 4,000’ 8,000’

N

HISTORICAL HIGH GROUNDWATER MAP

Hueneme High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303277-003

FIELD STUDY

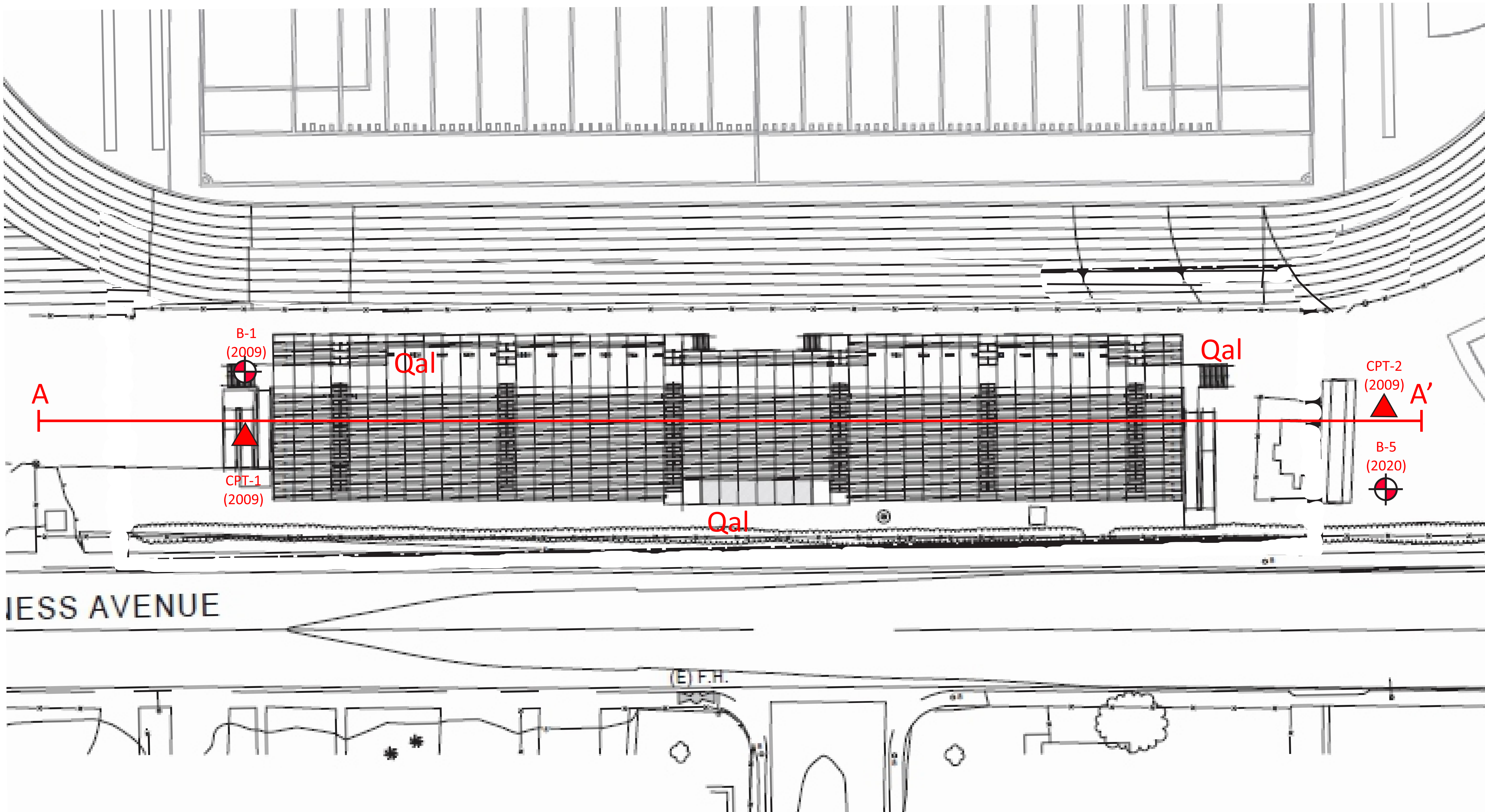
A. During site studies conducted in 2009, two Cone Penetrometer Test (CPT) soundings were advanced to depths of 50 feet to obtain information pertaining to the soil profile. The CPT soundings were performed using equipment owned and operated by Kehoe Testing and Engineering. During advancement of the cone penetrometer, readings of sleeve friction (in tons per square foot), tip resistance (also in tons per square foot), and friction ratio (in percent) were recorded at 0.15-meter intervals as per ASTM D 5778 and ASTM D 3441.

B. Also during studies conducted in 2009, an exploratory boring (Boring B-1) was drilled to a depth of 51.5 feet below the existing ground surface. This boring was supplemented by a new boring (Boring B-5) that was drilled on January 13, 2020. Both borings were advanced to depths of 51.5 feet using a mud rotary system.

C. Samples were obtained within the test borings with a Modified California (M.C.) ring sampler (ASTM D 3550 with shoe similar to ASTM D 1586), and with a Standard Penetration Test (SPT) sampler (ASTM D 1586). The M.C. sampler has a 3-inch outside diameter, and a 2.42-inch inside diameter when used with brass ring liners (as it was during this study). The SPT sampler has a 2.00-inch outside diameter and a 1.37-inch inside diameter, but when used without liners, as was done for this project, the inside diameter is 1.63 inches. The samples were obtained from the borings by driving the sampler with an automatic trip hammer dropping 30 inches in accordance with ASTM D 1586.

D. Bulk samples of the soils encountered in the upper 5 feet of Borings B-1 and B-5 were gathered from the cuttings.

E. The final logs of the borings represent interpretations of the contents of the field logs and the results of laboratory testing performed on the samples obtained during the subsurface study. The final logs, as well as the logs and interpretations of the CPT soundings, are included in this Appendix. The approximate locations of the borings and soundings were determined in the field by pacing and sighting and are shown on the Site Plan/Geologic Map in this Appendix.



Qal : Alluvial Deposits

A A' : Line of Cross-Section

CPT-2 : Cone Penetrometer Test (CPT) Sounding Locations

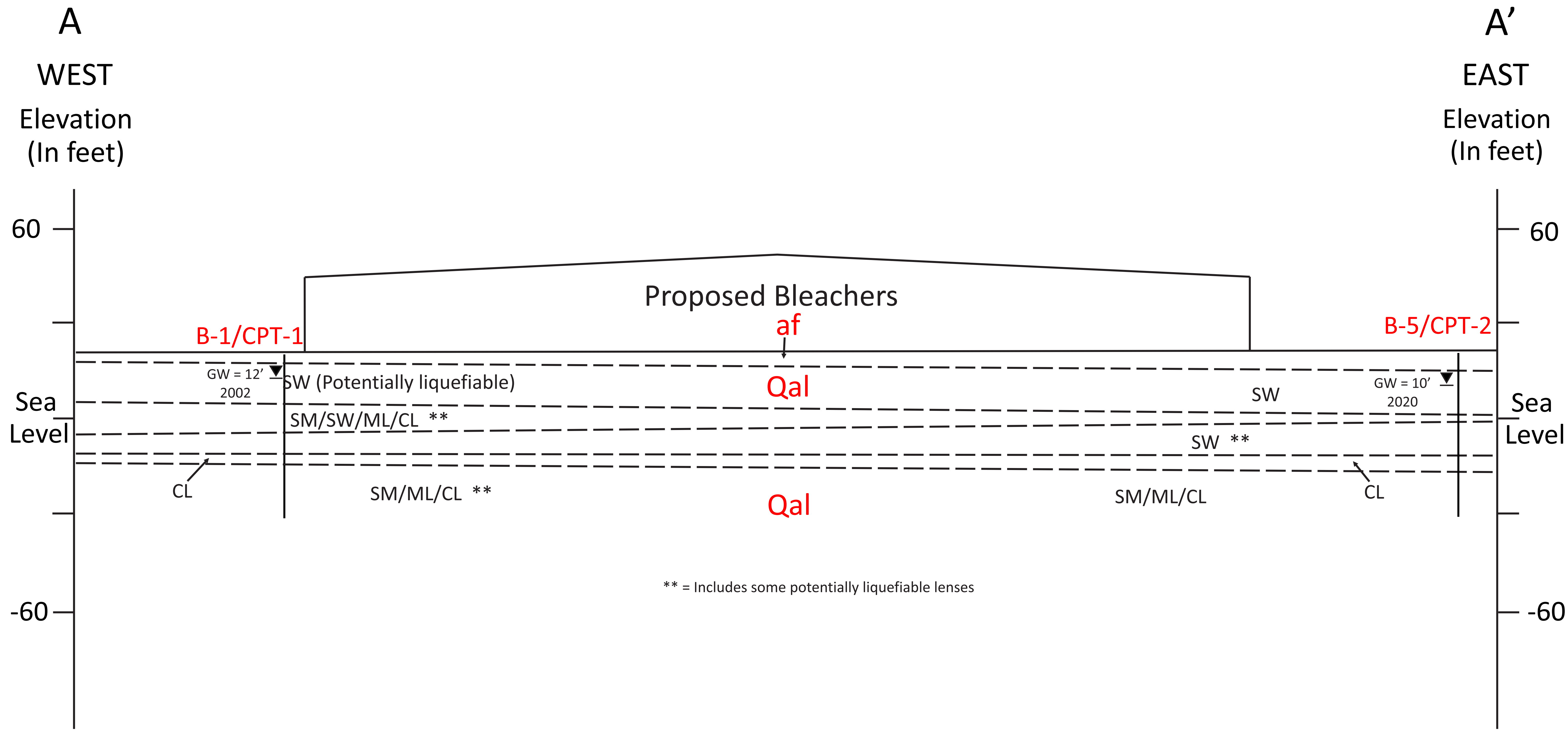
B-5 : Exploratory Boring Locations

Approximate Scale: 1" = 30'

0 30' 60'

N

GEOLOGIC MAP	
Hueneme High School Home Bleachers Oxnard, California	
Earth Systems	
February 2020	303277-003



SW: Well graded sands, little or no fines

SM: Silty-sands, sand-silt mixtures

ML: Interbedded silts and very fine sands, silty or clayey fine sands, or clayey silts

CL: Interbedded clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays.

Qal : Alluvial Deposits.

B-5 : Exploratory boring locations

CPT-2 : Cone Penetrometer Test (CPT) sounding locations

Approximate Scale: 1" = 30'

0 30' 60'

N

*Historic High Groundwater Approximately 6.5 Feet Below Surface

GEOLOGIC CROSS-SECTION A-A'

Hueneme High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303277-003

Earth Systems Southern California

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO. 1
PROJECT NAME: Hueneme High Bleachers
PROJECT NUMBER: VT-23434-03
BORING LOCATION: Per Plan

DRILLING DATE: December 23, 2009
DRILLING METHOD: 4 in. Diameter Rotary Wash
DRILL: Mobile Drill B-61
LOGGED BY: LT

Vertical Depth	Sample Type	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0	Bulk						**PAVEMENT:** 3in. A.C. over 4in. Aggregate Base
	Mod. Calif.	20/34/20		ML	113.8	8.3	**FILL:** Moderate yellowish brown sandy silt, moist,very dense.
	Mod. Calif.	5/5/7		SW-SM	97.7	6.4	**ALLUVIUM:** Moderate to pale yellowish brown silty to clean fine sand, moist, loose.
5	Mod. Calif.	5/9/15		SW	98.5	4.8	**ALLUVIUM:** Pale yellowish gray fine sand with some medium sand, moist, medium dense.
	Mod. Calif.	7/7/8			94.6	14.6	**ALLUVIUM:** Pale yellowish gray fine to medium sand, moist, loose.
10	Mod. Calif.	3/7/9		SW-SM	102.6	20.0	**ALLUVIUM:** Pale yellowish gray to yellowish brown silty fine to coarse sand, very moist, loose. ▼
	Mod. Calif.	7/7/8		SW-SM	99.8	24.6	**ALLUVIUM:** Thin lense of gravel then gray silty fine sand, saturated, loose.
15	SPT	4/10/10					**ALLUVIUM:** Gray silty fine to medium sand, medium dense.
	SPT	1/1/1		CH			**ALLUVIUM:** Interbedded olive gray marbled gray elastic silt, soft.
20	SPT	2/3/3		SW			**ALLUVIUM:** Sand, sample not recovered, loose.
	SPT	9/12/10		SW-SM			**ALLUVIUM:** Interbedded olive gray fine to coarse and fine to medium sand, medium dense.
25	SPT	4/8/5		SW			**ALLUVIUM:** 2 inch gravel lense over olive gray fine to coarse sand, medium dense.
	SPT	8/14/15		SM			**ALLUVIUM:** Olive gray silty fine to medium sand, dense.
30	SPT	1/2/2		CL			**ALLUVIUM:** Interbedded olive gray clay and sandy clay, soft to medium stiff.
35	SPT	1/5/5		ML			**ALLUVIUM:** Olive gray clayey to sandy silt, stiff.
				SM			**ALLUVIUM:** Olive gray silty fine sand to sandy silt, medium dense.

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems Southern California
1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO. 1 (Continued)	DRILLING DATE: December 23, 2009
PROJECT NAME: Hueneme High Bleachers	DRILLING METHOD: 4 in. Diameter Rotary Wash
PROJECT NUMBER: VT-23434-03	DRILL: Mobile Drill B-61
BORING LOCATION: Per Plan	LOGGED BY: LT

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
40		■		5/5/8		SM			**ALLUVIUM**: Olive gray silty fine sand to sandy silt, medium dense.
						SM-ML			**ALLUVIUM**: Olive gray sandy silt to silty sand, medium dense.
45		■		9/8/6					
						CL/SW			**ALLUVIUM**: Interbedded silty clay, clayey silt and sand, stiff to medium dense.
50		■		push/3/4					
									Total Depth = 51.5 Feet **Groundwater Encountered at 12 Feet**
55									
60									
65									
70									
75									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems

1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

BORING NO: B-5
PROJECT NAME: Hueneme High School Bleachers
PROJECT NUMBER: 303277-003
BORING LOCATION: Per Plan

DRILLING DATE: January 13, 2020
DRILL RIG: SIMCO
DRILLING METHOD: 4-Inch Mud Rotary
LOGGED BY: A. Luna

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0	X					SM			**FILL AND ALLUVIUM:** Dark Brown Silty fine Sand, trace Clay, medium dense, moist
5		■		6/6/8		SW			**ALLUVIUM:** Light Brown fine to medium Sand, trace to little coarse Sand, trace fine to coarse Gravel, medium dense, damp
		■		5/4/5		SW			**ALLUVIUM:** Light Brown fine to medium Sand, trace to little coarse Sand, trace fine to coarse Gravel, loose, moist
10	▼	■		4/6/6		SW			**ALLUVIUM:** Light Brown fine to medium Sand, trace coarse Sand, trace Gravel, trace Silt, medium dense, wet
		■		6/9/14		SW			**ALLUVIUM:** Gray Brown fine to coarse Sand, trace Silt, medium dense, wet
15		■		7/10/12					
		■		10/11/10		SW			**ALLUVIUM:** Gray Brown fine to medium Sand, trace Silt, medium dense, wet
20		■		2/1/2		ML		54.9	**ALLUVIUM:** Dark Gray Clayey Silt, soft, wet
		■		8/9/8		SM			**ALLUVIUM:** Dark Gray Silty fine Sand, medium dense, very moist
25		■		14/18/18		SP			**ALLUVIUM:** Gray fine Sand, trace medium Sand, little Silt, dense, wet
		■		11/14/23					
30		■		5/3/5		CL		27	**ALLUVIUM:** Gray Silty Clay, trace calcareous veining, medium stiff, very moist
		■		5/5/6		CL			**ALLUVIUM:** Brown Silty Clay, trace calcareous veining, stiff to very stiff, very moist
35		■		4/7/9				28.5	
		■		5/5/5		ML			**ALLUVIUM:** Gray Brown fine Sandy Silt, little Clay, stiff, wet

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

Earth Systems
1731-A Walter Street, Ventura, California 93003
PHONE: (805) 642-6727 FAX: (805) 642-1325

Boring No.: B-5 (Continued)	DRILLING DATE: January 13, 2020
PROJECT NAME: Hueneme High School Bleachers	DRILL RIG: SIMCO
PROJECT NUMBER: 303277-002	DRILLING METHOD: 4-Inch Mud Rotary
BORING LOCATION: Per Plan	LOGGED BY: A. Luna

Vertical Depth	Sample Type: Bulk	Sample Type: SPT	Sample Type: Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
40		■		10/13/8		SM			**ALLUVIUM:** Gray Brown Silty fine Sand, medium dense, wet
		■		13/15/11		ML			**ALLUVIUM:** Gray Brown Clayey Silt, very stiff, wet
45		■		8/10/11		ML		31.8	**ALLUVIUM:** Gray Silty fine Sand to fine Sandy Silt, medium dense to very stiff, very moist
		■		8/12/15		ML			**ALLUVIUM:** Gray fine Sandy Silt, little Clay, little fine Sand, medium dense, very moist
50		■		4/7/7		ML / CL		31.4	**ALLUVIUM:** Gray Silty Clay, stiff, very moist
									Total Depth: 51.5 feet
									Groundwater Depth: 10.0 feet
55									
60									
65									
70									
75									

Note: The stratification lines shown represent the approximate boundaries between soil and/or rock types and the transitions may be gradual.

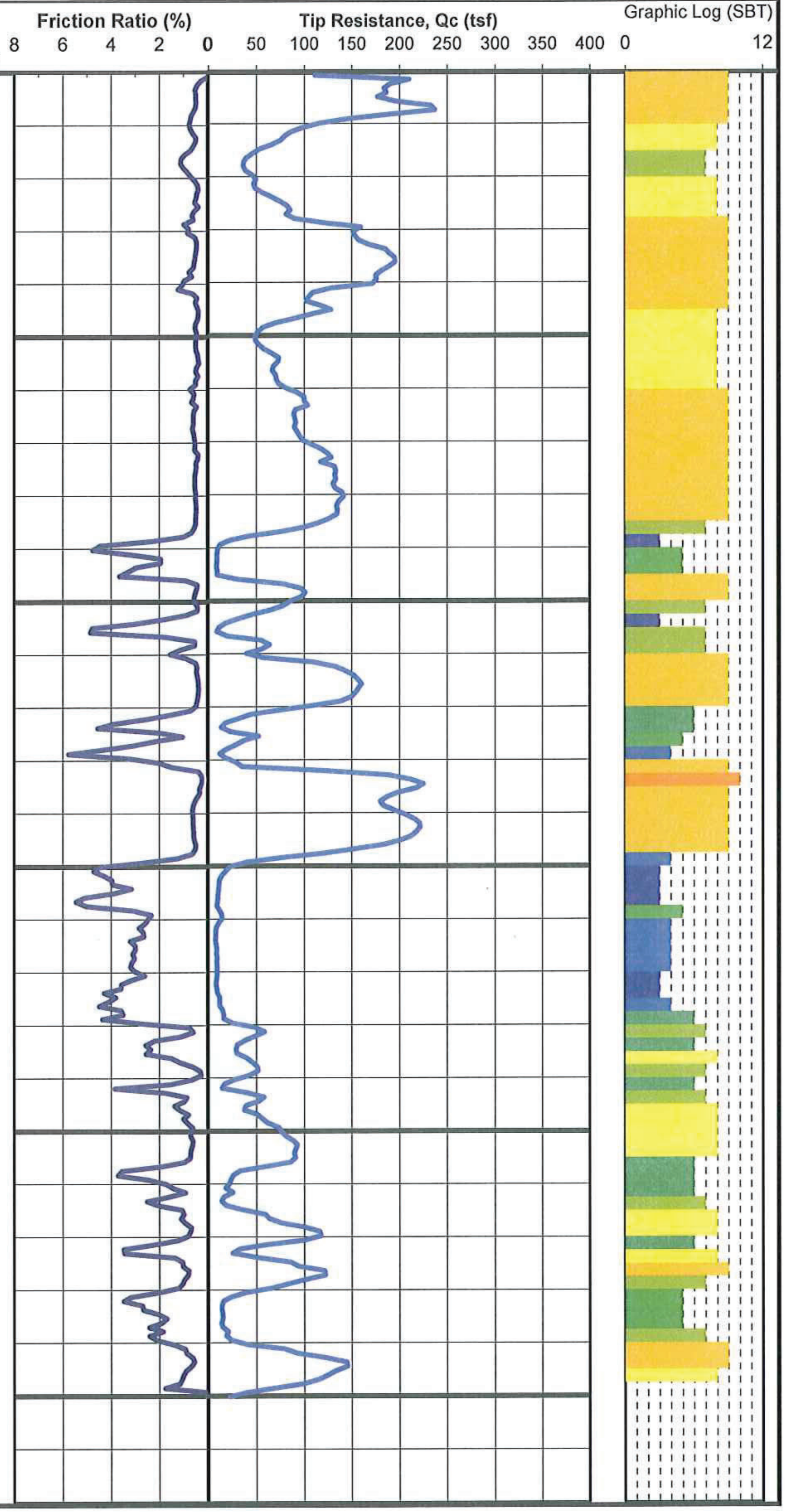
CPT No: CPT-1
Project Name: Hueneme High Bleachers
Project No.: 23434-03
Location: See Site Exploration Plan

CPT Vendor: **Kehoe Testing & Engineering**
Truck Mounted Electric
Cone with 30-ton reaction
Date: 12/17/2009

DEPTH (FEET): 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

Interpreted Soil Stratigraphy Robertson & Campanella ('89)	Density/Consistency
Sand	very dense
Sand	dense
Sand to Silty Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Sand to Silty Sand	medium dense
Sand	dense
Sand	dense
Sand	dense
Sand	medium dense
Sand to Silty Sand	medium dense
Sand to Silty Sand	medium dense
Sand to Silty Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Clayey Silt to Silty Clay	loose
Clayey Silt to Silty Clay	stiff
Sand	medium dense
Sandy Silt to Clayey Silt	loose
Silty Sand to Sandy Silt	medium dense
Sand	medium dense
Sand	medium dense
Sandy Silt to Clayey Silt	loose
Clayey Silt to Silty Clay	very stiff
Sand	medium dense
Sand	dense
Sand	dense
Silty Sand to Sandy Silt	medium dense
Clay	stiff
Silty Clay to Clay	stiff
Silty Clay to Clay	firm
Silty Clay to Clay	firm
Clay	firm
Clayey Silt to Silty Clay	very stiff
Sandy Silt to Clayey Silt	loose
Silty Sand to Sandy Silt	loose
Silty Sand to Sandy Silt	loose
Sand to Silty Sand	medium dense
Sand to Silty Sand	medium dense
Sandy Silt to Clayey Silt	very stiff
Sandy Silt to Clayey Silt	very stiff
Sand to Silty Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Sand to Silty Sand	medium dense
Clayey Silt to Silty Clay	stiff
Sandy Silt to Clayey Silt	very stiff
Sand	medium dense

End of Sounding @ 50.2 feet



CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Hueneme High Bleachers Project No: 23434-03 Date: 12/17/09

CPT SOUNDING: CPT-1 Plot: 1 Density: 1 SPT N Program developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Est. GWT (feet): **12.0** Dr correlation: 0 Baldi Qc/N: 0 Jefferies & Davies Phi Correlation: 4 SPT N

Base Depth meters	Base Depth feet	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	Qc to N	SPT N(60)	Total po tsf	p'o tsf	F	n	Cq	Norm. Qc1n	2.6 Ic	Clean Sand Qc1n	$N_{1(60)}$	Clean Sand $N_{1(60)}$	Rel. Dens. Dr (%)	Phi (deg.)	Nk: 17 Su (tsf)	OCR
0.15	0.5	194.53	0.42	Sand	SP	very dense	100	6.5	30	0.013	0.013	0.42	0.50	1.70	312.6	1.29	312.6	51	63	100	41		
0.30	1.0	185.88	0.48	Sand	SP	dense	100	6.4	29	0.038	0.038	0.48	0.50	1.70	298.7	1.35	298.7	50	60	100	40		
0.46	1.5	220.49	0.59	Sand	SP	very dense	100	6.4	35	0.063	0.063	0.59	0.50	1.70	354.3	1.35	354.3	59	71	100	42		
0.61	2.0	121.12	0.73	Sand	SP	dense	100	5.9	21	0.088	0.088	0.73	0.50	1.70	194.6	1.60	194.6	35	39	100	37		
0.76	2.5	80.57	0.53	Sand to Silty Sand	SP/SM	medium dense	100	5.8	14	0.113	0.113	0.53	0.50	1.70	129.5	1.65	130.2	24	26	88	34		
0.91	3.0	54.98	0.76	Sand to Silty Sand	SP/SM	medium dense	100	5.3	10	0.138	0.138	0.76	0.57	1.70	88.3	1.88	103.5	18	21	72	32		
1.07	3.5	37.34	1.07	Silty Sand to Sandy Silt	SM/ML	medium dense	110	4.9	8	0.164	0.164	1.08	0.64	1.70	60.0	2.10	87.8	13	18	56	31		
1.22	4.0	44.72	0.69	Silty Sand to Sandy Silt	SM/ML	medium dense	110	5.2	9	0.191	0.191	0.69	0.59	1.70	71.9	1.93	87.5	15	18	63	32		
1.37	4.5	50.56	0.42	Sand to Silty Sand	SP/SM	medium dense	100	5.5	9	0.218	0.218	0.42	0.54	1.70	81.2	1.77	81.2	16	16	68	32		
1.52	5.0	74.17	0.46	Sand to Silty Sand	SP/SM	medium dense	100	5.8	13	0.243	0.243	0.47	0.50	1.70	119.2	1.65	119.2	22	24	84	34		
1.68	5.5	94.29	0.70	Sand to Silty Sand	SP/SM	medium dense	100	5.7	16	0.268	0.268	0.70	0.51	1.70	151.5	1.67	154.3	28	31	94	36		
1.83	6.0	154.67	0.71	Sand	SP	dense	100	6.0	26	0.293	0.293	0.71	0.50	1.70	248.5	1.52	248.5	44	50	100	39		
1.98	6.5	169.85	0.46	Sand	SP	dense	100	6.3	27	0.318	0.318	0.46	0.50	1.70	272.9	1.36	272.9	46	55	100	40		
2.13	7.0	193.27	0.53	Sand	SP	very dense	100	6.3	30	0.343	0.343	0.53	0.50	1.70	310.5	1.36	310.5	52	62	100	41		
2.29	7.5	181.68	0.67	Sand	SP	dense	100	6.2	30	0.368	0.368	0.67	0.50	1.70	291.4	1.45	291.4	49	58	100	40		
2.44	8.0	158.66	1.08	Sand	SP	dense	100	5.8	28	0.393	0.393	1.08	0.50	1.65	247.2	1.65	248.4	44	50	100	39		
2.59	8.5	105.36	0.52	Sand	SP	medium dense	100	5.9	18	0.418	0.418	0.53	0.50	1.59	158.5	1.58	158.5	28	32	96	35		
2.74	9.0	117.86	0.40	Sand	SP	medium dense	120	6.1	19	0.445	0.445	0.40	0.50	1.54	171.8	1.48	171.8	29	34	99	36		
2.90	9.5	72.51	0.47	Sand to Silty Sand	SP/SM	medium dense	120	5.7	13	0.475	0.475	0.48	0.52	1.52	104.1	1.71	104.1	19	21	79	33		
3.05	10.0	49.77	0.47	Sand to Silty Sand	SP/SM	medium dense	120	5.4	9	0.505	0.505	0.47	0.56	1.52	71.4	1.85	71.4	13	14	63	31		
3.20	10.5	58.81	0.46	Sand to Silty Sand	SP/SM	medium dense	120	5.5	11	0.535	0.535	0.46	0.55	1.45	80.8	1.80	80.8	15	16	68	32		
3.35	11.0	71.46	0.40	Sand to Silty Sand	SP/SM	medium dense	120	5.7	13	0.565	0.565	0.40	0.52	1.39	93.8	1.71	93.8	17	19	74	32		
3.51	11.5	69.43	0.46	Sand to Silty Sand	SP/SM	medium dense	120	5.6	12	0.595	0.595	0.46	0.54	1.36	89.4	1.76	89.4	16	18	72	32		
3.66	12.0	82.33	0.59	Sand to Silty Sand	SP/SM	medium dense	120	5.5	15	0.625	0.625	0.59	0.54	1.33	103.3	1.76	111.6	19	22	78	33		
3.81	12.5	101.37	0.56	Sand	SP	medium dense	120	5.7	18	0.655	0.639	0.56	0.51	1.30	124.1	1.68	127.4	22	25	86	34		
3.96	13.0	90.14	0.57	Sand	SP	medium dense	120	5.6	16	0.685	0.654	0.57	0.53	1.29	109.9	1.73	116.4	20	23	81	33		
4.11	13.5	91.26	0.59	Sand	SP	medium dense	120	5.6	16	0.715	0.668	0.60	0.53	1.28	110.2	1.74	117.4	20	23	81	33		
4.27	14.0	100.76	0.53	Sand	SP	medium dense	120	5.7	18	0.745	0.683	0.53	0.51	1.25	119.3	1.68	122.5	21	25	84	34		
4.42	14.5	123.85	0.44	Sand	SP	medium dense	120	5.9	21	0.775	0.697	0.44	0.50	1.23	144.2	1.57	144.2	25	29	92	35		
4.57	15.0	127.39	0.48	Sand	SP	medium dense	120	5.9	22	0.805	0.711	0.48	0.50	1.22	146.8	1.59	146.8	26	29	93	35		
4.72	15.5	132.04	0.52	Sand	SP	medium dense	120	5.9	22	0.835	0.726	0.52	0.50	1.21	150.7	1.60	150.7	26	30	94	35		
4.88	16.0	137.50	0.49	Sand	SP	medium dense	120	5.9	23	0.865	0.740	0.50	0.50	1.20	155.4	1.57	155.4	27	31	95	35		
5.03	16.5	134.47	0.47	Sand	SP	medium dense	120	5.9	23	0.895	0.755	0.47	0.50	1.18	150.5	1.57	150.5	26	30	94	35		
5.18	17.0	114.03	0.50	Sand	SP	medium dense	120	5.8	20	0.925	0.769	0.51	0.50	1.17	126.6	1.65	127.2	23	25	87	34		
5.33	17.5	47.40	1.33	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.7	10	0.955	0.783	1.35	0.67	1.22	54.8	2.20	90.8	11	18	52	30		
5.49	18.0	10.25	4.17	Clay	CL/CH	stiff	120	3.1	3	0.985	0.798	4.61	0.92	1.30	12.6	3.03		3				0.56	3.5
5.64	18.5	8.80	2.28	Clayey Silt to Silty Clay	ML/CL	firm	120	3.2	3	1.015	0.812	2.57	0.90	1.27	10.6	2.94		3				0.47	2.9
5.79	19.0	16.56	2.61	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.6	5	1.045	0.827	2.78	0.84	1.23	19.3	2.75		5				0.93	5.6
5.94	19.5	91.92	0.46	Sand	SP	medium dense	120	5.6	16	1.075	0.841	0.46	0.53	1.13	98.0	1.72	98.0	18	20	76	33		
6.10	20.0	86.92	0.50	Sand	SP	medium dense	120	5.5	16	1.105	0.855	0.50	0.54	1.12	92.1	1.76	99.6	17	20	73	32		
6.25	20.5	47.88	1.05	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.8	10	1.135	0.870	1.08	0.66	1.14	51.5	2.16	80.9	11	16	49	30		
6.40	21.0	12.84	4.23	Clay	CL/CH	stiff	120	3.2	4	1.165	0.884	4.65	0.91	1.18	14.3	2.99		4				0.70	4.0
6.55	21.5	46.39	0.93	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.8	10	1.195	0.899	0.96	0.65	1.11	48.8	2.15	75.7	10	15	47	30		
6.71	22.0	50.86	1.19	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.7	11	1.225	0.913	1.22	0.66	1.10	53.0	2.18	85.8	11	17	50	30		
6.86	22.5	128.38	0.46	Sand	SP	medium dense	120	5.8	22	1.255	0.927	0.47	0.50	1.07	129.6	1.62	129.6	23	26	88	34		
7.01	23.0	156.17	0.39	Sand	SP	medium dense	120	6.0	26	1.285	0.942	0.40	0.50	1.06	156.4	1.52	156.4	27	31	95	35		
7.16	23.5	153.59	0.38	Sand	SP	medium dense	120	6.0	25	1.315	0.956	0.38	0.50	1.05	152.7	1.52	152.7	26	31	94	35		
7.32	24.0	108.27	0.54	Sand	SP	medium dense	120	5.6	19	1.345	0.971	0.55	0.53	1.05	107.1	1.73	113.3	20	23	80	33		
7.47	24.5	31.01	2.69	Sandy Silt to Clayey Silt	ML	loose	120	3.9	8	1.375	0.985	2.81	0.79	1.06	31.0	2.59	101.0	8	20	28	29		
7.62	25.0	29.77	2.54	Sandy Silt to Clayey Silt	ML	loose	120	3.9	8	1.405	0.999	2.67	0.79	1.05	29.4	2.59	96.3	8	19	26	29		
7.77	25.5	28.36	3.20	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.8	8	1.435	1.014	3.37	0.81	1.04	27.8	2.68		8				1.61	8.0
7.92	26.0	19.14	3.66	Silty Clay to Clay	CL	very stiff	120	3.4	6	1.465	1.028	3.97	0.87	1.03	18.5	2.86		6				1.07	5.2
8.08	26.5	138.81	0.58	Sand	SP	medium dense	120	5.7	24	1.495	1.043	0.59	0.51	1.01	132.2	1.67	134.7	24	27	88	34		
8.23	27.0	213.61	0.30	Gravelly Sand to Sand	SW	dense	120	6.3	34	1.525	1.057	0.30	0.50	1.00	202.0	1.36	202.0	33	40	100	37		
8.38	27.5	183.19	0.52	Sand	SP	medium dense	120	6.0	31	1.555	1.071	0.52	0.50	0.99	172.1	1.55	172.1	30	34	99	36		
8.53	28.0	204.68	0.60	Sand	SP	dense	120	6.0	34	1.585	1.086	0.61	0.50	0.99	191.0	1.55	191.0	33	38	100	37		
8.69	28.5	220.16	0.58	Sand	SP	dense	120	6.0	37	1.615	1.100	0.59	0.50	0.98	204.1	1.52	204.1	35	41	100	37		
8.84	29.0	198.63	0.53	Sand	SP	dense	120	6.0	33	1.645	1.115	0.53	0.50	0.97	182.9	1.53	182.9	31	37	100	36		
8.99	29.5	116.02	0.80	Sand	SP	medium dense	120	5.4	21	1.675	1.129	0.81	0.56	0.96	105.8	1.83	119.7	20	24	79	33		
9.14	30.0	27.02	3.97	Silty Clay to Clay	CL	very stiff	120	3.5	8	1.705	1.143	4.23	0.85	0.94	23.9	2.79		8				1.52	6.6
9.30	30.5	12.19	4.07	Clay	CL/CH	stiff	120	2.9	4	1.735	1.158	4.74	0.95	0.92	10.6	3.09		4				0.65	2.7
9.45	31.0	10.15	4.03	Clay	CL/CH	stiff	120	2.8	4	1.765	1.172	4.88	0.97	0.91	8.7	3.17		4				0.53	2.1
9.60	31.5	9.72	4.52	Clay	CL/CH	stiff	120	2.7	4	1.795	1.187	5.54	0.99	0.89	8.2	3.22		4				0.50	2.0
9.75	32.0	12.88	2.46	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.2	4	1.825	1.201	2.87	0.91	0.89	10.9	2.96		4				0.69	2.8
9.91	32.5	7.60	2.72	Silty Clay to Clay	CL	firm	120	2.7	3	1.855	1.215	3.60	0.99	0.87	6.3	3.21		3				0.38	1.4
10.06	33.0	8.06	3.06	Silty Clay to Clay	CL	firm	120	2.7	3	1.885	1.230	4.00	0.99	0.86	6.6	3.22		3				0.40	1.5
10.21	33.5	8.69	3.09	Silty Clay to Clay	CL	firm	120	2.8	3	1.915	1.244	3.96	0.98	0.85	7.0	3.19		3				0.44	1.6
10.36	34.0	9.00	2.94	Silty Clay to Clay	CL	firm	120	2.8	3	1.945	1.259	3.75	0.98	0.84	7.2	3.17		3				0.46	1.7
10.52	34.5	8.26	3.44	Clay	CL/CH	firm	120	2.6	3	1.975	1.273	4.51	1.00	0.83	6.5	3.25		3				0.41	1.5
10.67	35.0	10.72	4.07	Clay	CL/CH	stiff	120	2.8	4	2.005	1.287	5.00	0.98	0.83	8.4	3.19		4				0.55	2.0
10.82	35.5	13.88	3.86	Silty Clay to Clay	CL	stiff	120	3.0	5	2.035	1.302	4.52	0.94	0.82	10.8	3.08		5				0.74	2.7

Earth Systems
Southern California

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Hueneme High Bleachers Project No: 23434-03 Date: 12/17/09

CPT SOUNDING: CPT-1 Plot: 1 Density: 1 SPT N Program developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Est. GWT (feet): **12.0** Dr correlation: 0 Baldi Qc/N: 0 Jefferies & Davies Phi Correlation: 4 SPT N

Base Depth meters	Base Depth feet	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	Qc to N	SPT N(60)	Total po tsf	p'o tsf	F	n	Cq	Norm. Qc1n	2.6 Ic	Clean Sand Qc1n	$N_{1(60)}$	Clean Sand $N_{1(60)}$	Rel. Dens. Dr (%)	Phi (deg.)	Nk: 17 Su (tsf)	OCR
10.97	36.0	29.74	2.60	Sandy Silt to Clayey Silt	ML	very stiff	120	3.8	8	2.065	1.316	2.80	0.82	0.84	23.5	2.68		8				1.67	6.3
11.13	36.5	43.98	1.61	Silty Sand to Sandy Silt	SM/ML	loose	120	4.3	10	2.095	1.331	1.70	0.73	0.85	35.1	2.41	82.5	9	17	33	30		
11.28	37.0	32.47	2.14	Sandy Silt to Clayey Silt	ML	very stiff	120	3.9	8	2.125	1.345	2.29	0.79	0.83	25.4	2.60		8				1.83	6.8
11.43	37.5	49.48	0.68	Sand to Silty Sand	SP/SM	loose	120	4.8	10	2.155	1.359	0.71	0.66	0.85	39.7	2.16	62.2	9	12	38	30		
11.58	38.0	29.10	0.83	Silty Sand to Sandy Silt	SM/ML	loose	120	4.3	7	2.185	1.374	0.89	0.74	0.82	22.7	2.42	54.1	6	11	15	28		
11.73	38.5	37.16	2.15	Sandy Silt to Clayey Silt	ML	loose	120	4.0	9	2.215	1.388	2.28	0.78	0.81	28.4	2.56	88.0	8	18	25	29		
11.89	39.0	42.88	1.16	Silty Sand to Sandy Silt	SM/ML	loose	120	4.4	10	2.245	1.403	1.23	0.72	0.82	33.1	2.35	70.1	8	14	31	29		
12.04	39.5	56.30	0.87	Sand to Silty Sand	SP/SM	loose	120	4.7	12	2.275	1.417	0.91	0.66	0.82	43.8	2.17	70.5	10	14	43	30		
12.19	40.0	77.06	0.67	Sand to Silty Sand	SP/SM	medium dense	120	5.1	15	2.305	1.431	0.69	0.61	0.83	60.6	1.99	78.1	13	16	56	31		
12.34	40.5	90.86	0.63	Sand to Silty Sand	SP/SM	medium dense	120	5.2	17	2.335	1.446	0.65	0.59	0.83	71.5	1.92	86.3	14	17	63	31		
12.50	41.0	88.85	0.79	Sand to Silty Sand	SP/SM	medium dense	120	5.1	17	2.365	1.460	0.81	0.61	0.82	69.1	1.98	88.5	14	18	61	31		
12.65	41.5	39.90	3.08	Sandy Silt to Clayey Silt	ML	hard	120	3.8	10	2.395	1.475	3.28	0.81	0.76	28.8	2.66		10				2.26	7.6
12.80	42.0	20.98	1.88	Sandy Silt to Clayey Silt	ML	very stiff	120	3.6	6	2.425	1.489	2.12	0.85	0.75	14.8	2.77		6				1.15	3.7
12.95	42.5	18.21	1.69	Sandy Silt to Clayey Silt	ML	stiff	120	3.5	5	2.455	1.503	1.95	0.86	0.74	12.7	2.81		5				0.98	3.1
13.11	43.0	37.87	1.34	Silty Sand to Sandy Silt	SM/ML	loose	120	4.2	9	2.485	1.518	1.44	0.75	0.76	27.3	2.46	69.8	7	14	23	29		
13.26	43.5	80.28	0.90	Sand to Silty Sand	SP/SM	medium dense	120	5.0	16	2.515	1.532	0.93	0.63	0.79	60.1	2.07	84.1	13	17	56	31		
13.41	44.0	111.25	0.92	Sand to Silty Sand	SP/SM	medium dense	120	5.2	21	2.545	1.547	0.94	0.60	0.80	83.9	1.95	104.2	17	21	70	32		
13.56	44.5	39.54	3.06	Sandy Silt to Clayey Silt	ML	hard	120	3.8	11	2.575	1.561	3.28	0.81	0.73	27.2	2.67		11				2.23	7.1
13.72	45.0	77.31	1.14	Sand to Silty Sand	SP/SM	medium dense	120	4.8	16	2.605	1.575	1.18	0.66	0.77	56.3	2.15	87.4	13	17	53	31		
13.87	45.5	115.28	0.85	Sand	SP	medium dense	120	5.2	22	2.635	1.590	0.87	0.59	0.79	85.8	1.92	104.0	17	21	70	32		
14.02	46.0	63.37	1.43	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.5	14	2.665	1.604	1.49	0.70	0.75	44.8	2.29	86.0	11	17	43	30		
14.17	46.5	17.62	3.12	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.1	6	2.695	1.619	3.68	0.92	0.68	11.3	3.01		6				0.94	2.8
14.33	47.0	14.19	2.08	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.1	5	2.725	1.633	2.58	0.92	0.67	9.0	3.00		5				0.74	2.1
14.48	47.5	17.87	2.23	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.3	5	2.755	1.647	2.64	0.89	0.67	11.4	2.92		5				0.95	2.8
14.63	48.0	48.25	1.48	Silty Sand to Sandy Silt	SM/ML	loose	120	4.3	11	2.785	1.662	1.57	0.74	0.72	32.7	2.41	77.6	9	16	30	30		
14.78	48.5	120.05	0.68	Sand	SP	medium dense	120	5.4	22	2.815	1.676	0.69	0.57	0.77	87.3	1.86	100.8	17	20	71	32		
14.94	49.0	134.59	0.85	Sand	SP	medium dense	120	5.3	25	2.845	1.691	0.87	0.57	0.76	97.2	1.88	113.9	19	23	76	33		
15.09	49.5	94.82	1.32	Sand to Silty Sand	SP/SM	medium dense	120	4.8	20	2.875	1.705	1.36	0.65	0.73	65.7	2.14	100.1	15	20	59	32		
15.24	50.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	###	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Earth Systems
Southern California

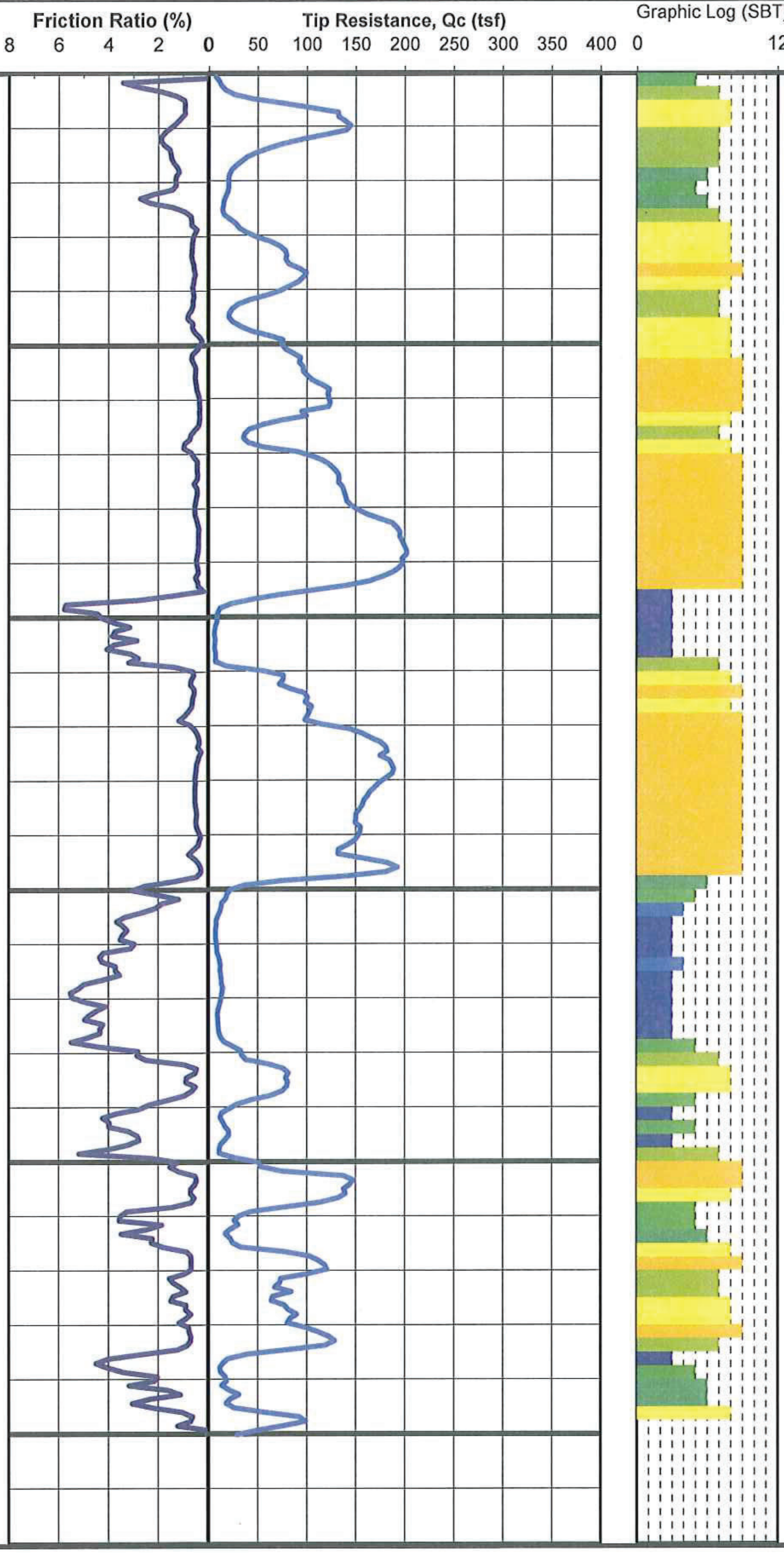
CPT No: CPT-2
Project Name: Hueneme High Bleachers
Project No.: 23434-03
Location: See Site Exploration Plan

CPT Vendor: **Kehoe Testing & Engineering**
Truck Mounted Electric
Cone with 30-ton reaction
Date: 12/17/2009

DEPTH (FEET)

Interpreted Soil Stratigraphy Robertson & Campanella ('89)	Density/Consistency
Sandy Silt to Clayey Silt	medium dense
Sand to Silty Sand	dense
Silty Sand to Sandy Silt	medium dense
Sandy Silt to Clayey Silt	loose
Sandy Silt to Clayey Silt	loose
Silty Sand to Sandy Silt	medium dense
Sand to Silty Sand	medium dense
Sand to Silty Sand	medium dense
Silty Sand to Sandy Silt	loose
Sand to Silty Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand to Silty Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	dense
Sand	dense
Sand	medium dense
Clay	stiff
Clay	firm
Sandy Silt to Clayey Silt	loose
Sand to Silty Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Clayey Silt to Silty Clay	stiff
Clay	firm
Clay	stiff
Clay	stiff
Clay	firm
Silty Clay to Clay	very stiff
Sand to Silty Sand	medium dense
Sandy Silt to Clayey Silt	loose
Silty Clay to Clay	stiff
Clayey Silt to Silty Clay	very stiff
Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Sandy Silt to Clayey Silt	very stiff
Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Sand to Silty Sand	medium dense
Silty Sand to Sandy Silt	medium dense
Silty Clay to Clay	stiff
Sandy Silt to Clayey Silt	very stiff

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50



End of Sounding @ 50.2 feet

Earth Systems
Southern California

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Hueneme High Bleachers | Project No: 23434-03 | Date: 12/17/09

CPT SOUNDING: CPT-2 | Plot: 2 | Density: 1 SPT N | Program developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Est. GWT (feet): **12.0** | Dr correlation: 0 Baldi | Qc/N: 0 Jefferies & Davies | Phi Correlation: 4 SPT N

Base Depth meters	Base Depth feet	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	Qc to N	SPT N(60)	Total po tsf	p'o tsf	F	n	Cq	Norm. Qc1n	2.6 Ic	Clean Sand Qc1n	$N_{1(60)}$	Clean Sand $N_{1(60)}$	Rel. Dens. Dr (%)	Phi (deg.)	Nk: 17 Su (tsf)	OCR
0.15	0.5	13.45	2.69	Clayey Silt to Silty Clay	ML/CL	stiff	110	3.7	4	0.014	0.014	2.69	0.82	1.70	21.6	2.70		4				0.79	####
0.30	1.0	48.62	1.04	Silty Sand to Sandy Silt	SM/ML	medium dense	110	5.1	10	0.041	0.041	1.05	0.61	1.70	78.1	2.01	102.2	16	20	67	32		
0.46	1.5	122.61	0.98	Sand to Silty Sand	SP/SM	dense	100	5.7	22	0.068	0.068	0.98	0.51	1.70	197.0	1.69	202.9	37	41	100	38		
0.61	2.0	141.30	1.48	Sand to Silty Sand	SP/SM	dense	100	5.5	26	0.093	0.093	1.48	0.54	1.70	227.0	1.78	248.3	44	50	100	39		
0.76	2.5	97.59	1.85	Silty Sand to Sandy Silt	SM/ML	dense	110	5.2	19	0.119	0.119	1.85	0.60	1.70	156.8	1.96	196.1	32	39	95	37		
0.91	3.0	49.88	1.51	Silty Sand to Sandy Silt	SM/ML	medium dense	110	4.9	10	0.146	0.146	1.51	0.64	1.70	80.1	2.10	116.6	17	23	68	32		
1.07	3.5	27.87	1.26	Silty Sand to Sandy Silt	SM/ML	medium dense	110	4.6	6	0.174	0.174	1.27	0.68	1.70	44.8	2.25	80.4	10	16	43	30		
1.22	4.0	20.32	1.30	Sandy Silt to Clayey Silt	ML	loose	110	4.4	5	0.201	0.201	1.31	0.72	1.70	32.7	2.37	71.6	8	14	30	29		
1.37	4.5	18.77	2.12	Clayey Silt to Silty Clay	ML/CL	loose	110	4.1	5	0.229	0.229	2.14	0.77	1.70	30.2	2.52	87.2	8	17	27	29		
1.52	5.0	14.68	1.56	Sandy Silt to Clayey Silt	ML	loose	110	4.0	4	0.256	0.256	1.58	0.77	1.70	23.6	2.53	69.3	6	14	17	29		
1.68	5.5	24.04	0.61	Silty Sand to Sandy Silt	SM/ML	loose	110	4.8	5	0.284	0.284	0.62	0.65	1.70	38.6	2.14	58.9	8	12	37	29		
1.83	6.0	50.36	0.59	Sand to Silty Sand	SP/SM	medium dense	100	5.4	9	0.310	0.310	0.59	0.56	1.70	80.9	1.85	92.6	16	19	68	32		
1.98	6.5	76.67	0.65	Sand to Silty Sand	SP/SM	medium dense	100	5.6	14	0.335	0.335	0.66	0.53	1.70	123.2	1.73	130.0	23	26	85	34		
2.13	7.0	84.19	0.58	Sand to Silty Sand	SP/SM	medium dense	100	5.7	15	0.360	0.360	0.58	0.51	1.70	135.3	1.66	137.0	24	27	89	35		
2.29	7.5	95.47	0.55	Sand	SP	medium dense	100	5.8	16	0.385	0.385	0.55	0.50	1.66	149.6	1.61	149.6	26	30	94	35		
2.44	8.0	70.95	0.59	Sand to Silty Sand	SP/SM	medium dense	100	5.6	13	0.410	0.410	0.59	0.53	1.65	110.9	1.74	117.8	20	24	81	33		
2.59	8.5	31.72	0.62	Silty Sand to Sandy Silt	SM/ML	loose	110	5.0	6	0.436	0.436	0.63	0.62	1.70	51.0	2.04	68.8	10	14	49	30		
2.74	9.0	21.69	0.74	Silty Sand to Sandy Silt	SM/ML	loose	120	4.7	5	0.465	0.465	0.75	0.67	1.70	35.2	2.21	59.9	7	12	33	29		
2.90	9.5	45.26	0.51	Sand to Silty Sand	SP/SM	medium dense	120	5.3	9	0.495	0.495	0.51	0.58	1.55	66.3	1.89	78.4	12	16	60	31		
3.05	10.0	76.12	0.33	Sand to Silty Sand	SP/SM	medium dense	120	5.8	13	0.525	0.525	0.33	0.50	1.42	102.2	1.64	102.2	18	20	78	33		
3.20	10.5	90.62	0.62	Sand to Silty Sand	SP/SM	medium dense	120	5.6	16	0.555	0.555	0.63	0.53	1.40	120.3	1.72	126.6	22	25	84	34		
3.35	11.0	97.72	0.50	Sand	SP	medium dense	120	5.8	17	0.585	0.585	0.51	0.51	1.35	124.6	1.66	125.6	22	25	86	34		
3.51	11.5	114.92	0.47	Sand	SP	medium dense	120	5.9	20	0.615	0.615	0.47	0.50	1.31	142.5	1.59	142.5	25	28	92	35		
3.66	12.0	122.79	0.35	Sand	SP	medium dense	120	6.0	20	0.645	0.645	0.36	0.50	1.28	148.6	1.51	148.6	25	30	93	35		
3.81	12.5	105.46	0.33	Sand	SP	medium dense	120	5.9	18	0.675	0.659	0.33	0.50	1.27	126.3	1.56	126.3	22	25	87	34		
3.96	13.0	56.48	0.42	Sand to Silty Sand	SP/SM	medium dense	120	5.4	10	0.705	0.674	0.42	0.56	1.29	68.8	1.84	68.8	13	14	61	31		
4.11	13.5	37.29	0.78	Silty Sand to Sandy Silt	SM/ML	loose	120	4.8	8	0.735	0.688	0.80	0.65	1.32	46.6	2.12	69.7	9	14	45	30		
4.27	14.0	83.78	0.74	Sand to Silty Sand	SP/SM	medium dense	120	5.4	15	0.765	0.703	0.75	0.56	1.26	99.6	1.83	112.8	18	23	77	33		
4.42	14.5	123.02	0.43	Sand	SP	medium dense	120	5.9	21	0.795	0.717	0.43	0.50	1.21	141.2	1.57	141.2	25	28	91	35		
4.57	15.0	132.56	0.47	Sand	SP	medium dense	120	5.9	22	0.825	0.731	0.47	0.50	1.20	150.7	1.57	150.7	26	30	94	35		
4.72	15.5	138.12	0.44	Sand	SP	medium dense	120	6.0	23	0.855	0.746	0.44	0.50	1.19	155.5	1.54	155.5	27	31	95	35		
4.88	16.0	149.73	0.52	Sand	SP	medium dense	120	5.9	25	0.885	0.760	0.52	0.50	1.18	167.0	1.56	167.0	29	33	98	36		
5.03	16.5	184.37	0.41	Sand	SP	dense	120	6.2	30	0.915	0.775	0.41	0.50	1.17	203.7	1.43	203.7	34	41	100	37		
5.18	17.0	195.87	0.38	Sand	SP	dense	120	6.3	31	0.945	0.789	0.38	0.50	1.16	214.4	1.39	214.4	35	43	100	37		
5.33	17.5	200.95	0.40	Sand	SP	dense	120	6.3	32	0.975	0.803	0.40	0.50	1.15	218.0	1.40	218.0	36	44	100	37		
5.49	18.0	196.45	0.43	Sand	SP	dense	120	6.2	32	1.005	0.818	0.43	0.50	1.14	211.2	1.43	211.2	35	42	100	37		
5.64	18.5	176.26	0.43	Sand	SP	dense	120	6.1	29	1.035	0.832	0.43	0.50	1.13	187.8	1.47	187.8	32	38	100	36		
5.79	19.0	106.67	0.66	Sand	SP	medium dense	120	5.6	19	1.065	0.847	0.67	0.54	1.13	113.6	1.76	122.5	21	24	82	33		
5.94	19.5	26.57	4.75	Clay	CL/CH	very stiff	120	3.6	7	1.095	0.861	4.95	0.84	1.19	29.9	2.77		7				1.51	8.9
6.10	20.0	8.68	4.18	Clay	CL/CH	firm	120	2.9	3	1.125	0.875	4.60	0.96	1.20	9.8	3.12		3				0.46	2.6
6.25	20.5	6.09	3.58	Clay	CL/CH	firm	120	2.7	2	1.155	0.890	4.42	0.99	1.19	6.8	3.23		2				0.31	1.7
6.40	21.0	6.15	3.57	Clay	CL/CH	firm	120	2.7	2	1.185	0.904	4.42	0.99	1.17	6.8	3.23		2				0.31	1.6
6.55	21.5	6.82	3.04	Clay	CL/CH	firm	120	2.8	2	1.215	0.919	3.69	0.97	1.15	7.4	3.16		2				0.35	1.8
6.71	22.0	50.22	0.83	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.9	10	1.245	0.933	0.86	0.64	1.08	51.4	2.10	75.1	11	15	49	30		
6.86	22.5	77.18	0.64	Sand to Silty Sand	SP/SM	medium dense	120	5.3	15	1.275	0.947	0.65	0.58	1.07	77.7	1.89	91.5	15	18	66	32		
7.01	23.0	99.12	0.59	Sand	SP	medium dense	120	5.5	18	1.305	0.962	0.60	0.54	1.05	98.7	1.78	107.9	18	22	76	33		
7.16	23.5	103.09	0.79	Sand to Silty Sand	SP/SM	medium dense	120	5.4	19	1.335	0.976	0.80	0.56	1.05	101.9	1.84	116.1	19	23	78	33		
7.32	24.0	118.65	0.81	Sand	SP	medium dense	120	5.5	22	1.365	0.991	0.82	0.55	1.04	116.3	1.80	129.0	22	26	83	34		
7.47	24.5	166.05	0.38	Sand	SP	medium dense	120	6.1	27	1.395	1.005	0.38	0.50	1.03	161.0	1.49	161.0	27	32	97	35		
7.62	25.0	179.26	0.34	Sand	SP	medium dense	120	6.2	29	1.425	1.019	0.34	0.50	1.02	172.6	1.45	172.6	29	35	99	36		
7.77	25.5	186.80	0.44	Sand	SP	dense	120	6.1	31	1.455	1.034	0.44	0.50	1.01	178.6	1.49	178.6	30	36	100	36		
7.92	26.0	180.91	0.50	Sand	SP	medium dense	120	6.0	30	1.485	1.048	0.50	0.50	1.00	171.8	1.54	171.8	30	34	99	36		
8.08	26.5	164.11	0.51	Sand	SP	medium dense	120	5.9	28	1.515	1.063	0.52	0.50	1.00	154.8	1.58	154.8	27	31	95	35		
8.23	27.0	154.01	0.47	Sand	SP	medium dense	120	5.9	26	1.545	1.077	0.48	0.50	0.99	144.3	1.59	144.3	25	29	92	35		
8.38	27.5	151.61	0.46	Sand	SP	medium dense	120	5.9	26	1.575	1.091	0.47	0.50	0.98	141.1	1.59	141.1	25	28	91	35		
8.53	28.0	152.03	0.33	Sand	SP	medium dense	120	6.0	25	1.605	1.106	0.33	0.50	0.98	140.6	1.52	140.6	24	28	91	34		
8.69	28.5	135.27	0.59	Sand	SP	medium dense	120	5.7	24	1.635	1.120	0.59	0.52	0.97	124.1	1.70	128.6	23	26	86	34		
8.84	29.0	178.23	0.39	Sand	SP	medium dense	120	6.1	29	1.665	1.135	0.40	0.50	0.97	162.7	1.50	162.7	28	33	97	35		
8.99	29.5	132.20	0.69	Sand	SP	medium dense	120	5.6	24	1.695	1.149	0.70	0.53	0.96	119.6	1.75	128.3	22	26	84	34		
9.14	30.0	25.68	2.55	Sandy Silt to Clayey Silt	ML	very stiff	120	3.7	7	1.725	1.163	2.73	0.82	0.93	22.5	2.69		7				1.44	6.2
9.30	30.5	14.39	1.73	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.5	4	1.755	1.178	1.97	0.86	0.91	12.4	2.82		4				0.78	3.2
9.45	31.0	9.26	3.23	Silty Clay to Clay	CL	firm	120	2.8	3	1.785	1.192	4.01	0.97	0.89	7.8	3.16		3				0.47	1.9
9.60	31.5	7.10	3.37	Clay	CL/CH	firm	120	2.6	3	1.815	1.207	4.53	1.00	0.88	5.9	3.29		3				0.35	1.3
9.75	32.0	7.58	3.20	Clay	CL/CH	firm	120	2.6	3	1.845	1.221	4.23	1.00	0.87	6.2	3.25		3				0.37	1.4
9.91	32.5	9.87	4.27	Clay	CL/CH	stiff	120	2.7	4	1.875	1.235	5.28	0.99	0.86	8.0	3.22		4				0.51	1.9
10.06	33.0	11.80	3.67	Silty Clay to Clay	CL	stiff	120	2.9	4	1.905	1.250	4.37	0.95	0.85	9.5	3.11		4				0.62	2.4
10.21	33.5	13.25	4.80	Clay	CL/CH	stiff	120	2.9	5	1.935	1.264	5.62	0.96	0.84	10.6	3.14		5				0.70	2.7
10.36	34.0	12.73	5.31	Clay	CL/CH	stiff	120	2.8	5	1.965	1.279	6.28	0.98	0.83	10.0	3.19		5				0.67	2.5
10.52	34.5	9.63	4.46	Clay	CL/CH	firm	120	2.6	4	1.995	1.293	5.63	1.00	0.82	7.5	3.26		4				0.49	1.8
10.67	35.0	9.55	4.51	Clay	CL/CH	firm	120	2.6	4	2.025	1.307	5.72	1.00	0.81	7.3	3.27		4				0.48	1.7
10.82	35.5	12.69	4.89	Clay	CL/CH	stiff	120	2.8	5	2.055	1.322	5.83	0.97	0.81	9.7	3.18		5				0.67	2.4

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Hueneme High Bleachers Project No: 23434-03 Date: 12/17/09

CPT SOUNDING: CPT-2 Plot: 2 Density: 1 SPT N Program developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Est. GWT (feet): **12.0** Dr correlation: 0 Baldi Qc/N: 0 Jefferies & Davies Phi Correlation: 4 SPT N

Base Depth meters	Base Depth feet	Avg Tip Qc, tsf	Avg Friction Ratio, %	Soil Classification	USCS	Density or Consistency	Est. Density (pcf)	Qc to N	SPT N(60)	Total po tsf	p'o tsf	F	n	Cq	Norm. Qc1n	2.6 Ic	Clean Sand Qc1n	$N_{1(60)}$	Clean Sand $N_{1(60)}$	Rel. Dens. Dr (%)	Phi (deg.)	Nk: 17 Su (tsf)	OCR
10.97	36.0	30.02	3.36	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.6	8	2.085	1.336	3.61	0.84	0.82	23.3	2.75		8				1.69	6.3
11.13	36.5	64.01	1.11	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.7	14	2.115	1.351	1.15	0.66	0.85	51.5	2.18	82.8	12	17	49	31		
11.28	37.0	79.61	0.75	Sand to Silty Sand	SP/SM	medium dense	120	5.1	16	2.145	1.365	0.77	0.61	0.86	64.4	2.00	83.4	13	17	59	31		
11.43	37.5	60.77	1.07	Sand to Silty Sand	SP/SM	medium dense	120	4.7	13	2.175	1.379	1.11	0.67	0.84	48.1	2.19	79.1	11	16	46	30		
11.58	38.0	20.88	2.94	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.4	6	2.205	1.394	3.29	0.88	0.79	15.5	2.87		6				1.15	4.0
11.73	38.5	14.21	4.07	Clay	CL/CH	stiff	120	2.9	5	2.235	1.408	4.83	0.95	0.76	10.2	3.11		5				0.75	2.6
11.89	39.0	19.12	2.94	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.3	6	2.265	1.423	3.34	0.89	0.77	13.9	2.91		6				1.04	3.6
12.04	39.5	11.10	4.14	Clay	CL/CH	stiff	120	2.7	4	2.295	1.437	5.22	0.99	0.74	7.7	3.23		4				0.57	1.8
12.19	40.0	43.68	1.66	Silty Sand to Sandy Silt	SM/ML	loose	120	4.2	10	2.325	1.451	1.76	0.74	0.79	32.6	2.44	81.6	9	16	30	29		
12.34	40.5	119.55	0.72	Sand	SP	medium dense	120	5.4	22	2.355	1.466	0.73	0.56	0.83	94.0	1.85	107.5	18	22	74	33		
12.50	41.0	140.31	0.64	Sand	SP	medium dense	120	5.5	25	2.385	1.480	0.65	0.54	0.83	110.7	1.76	119.5	21	24	81	33		
12.65	41.5	108.21	0.90	Sand to Silty Sand	SP/SM	medium dense	120	5.2	21	2.415	1.495	0.92	0.59	0.81	83.3	1.95	103.2	17	21	69	32		
12.80	42.0	33.70	3.46	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.6	9	2.445	1.509	3.73	0.84	0.74	23.6	2.76		9				1.89	6.2
12.95	42.5	22.78	2.61	Clayey Silt to Silty Clay	ML/CL	very stiff	120	3.5	7	2.475	1.523	2.93	0.86	0.73	15.7	2.83		7				1.25	4.0
13.11	43.0	26.38	2.11	Sandy Silt to Clayey Silt	ML	very stiff	120	3.7	7	2.505	1.538	2.33	0.83	0.73	18.3	2.72		7				1.46	4.7
13.26	43.5	96.95	0.74	Sand to Silty Sand	SP/SM	medium dense	120	5.2	19	2.535	1.552	0.76	0.59	0.80	73.0	1.95	90.2	15	18	64	32		
13.41	44.0	113.39	0.76	Sand	SP	medium dense	120	5.3	21	2.565	1.567	0.78	0.58	0.80	85.4	1.90	101.3	17	20	70	32		
13.56	44.5	71.17	1.35	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.6	15	2.595	1.581	1.40	0.68	0.76	51.2	2.23	89.1	12	18	49	31		
13.72	45.0	71.34	1.26	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.7	15	2.625	1.595	1.31	0.67	0.76	51.1	2.21	86.6	12	17	49	31		
13.87	45.5	82.71	0.82	Sand to Silty Sand	SP/SM	medium dense	120	5.0	17	2.655	1.610	0.85	0.62	0.77	60.2	2.04	81.9	13	16	56	31		
14.02	46.0	87.52	0.94	Sand to Silty Sand	SP/SM	medium dense	120	5.0	18	2.685	1.624	0.97	0.63	0.76	63.2	2.06	87.6	14	18	58	31		
14.17	46.5	121.18	0.71	Sand	SP	medium dense	120	5.4	23	2.715	1.639	0.72	0.57	0.78	89.3	1.86	103.2	18	21	72	33		
14.33	47.0	64.81	2.18	Silty Sand to Sandy Silt	SM/ML	medium dense	120	4.3	15	2.745	1.653	2.28	0.73	0.72	44.1	2.41	104.3	12	21	43	31		
14.48	47.5	12.54	3.98	Clay	CL/CH	stiff	120	2.7	5	2.775	1.667	5.11	0.99	0.64	7.5	3.23		5				0.64	1.8
14.63	48.0	16.15	2.46	Clayey Silt to Silty Clay	ML/CL	stiff	120	3.1	5	2.805	1.682	2.98	0.92	0.65	10.0	3.00		5				0.85	2.4
14.78	48.5	24.42	1.68	Sandy Silt to Clayey Silt	ML	very stiff	120	3.7	7	2.835	1.696	1.90	0.83	0.67	15.6	2.73		7				1.34	3.8
14.94	49.0	33.97	2.08	Sandy Silt to Clayey Silt	ML	very stiff	120	3.8	9	2.865	1.711	2.27	0.81	0.68	21.8	2.65		9				1.90	5.5
15.09	49.5	88.98	0.84	Sand to Silty Sand	SP/SM	medium dense	120	5.0	18	2.895	1.725	0.86	0.62	0.74	62.0	2.04	83.9	14	17	57	31		
15.24	50.0	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	###	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

BORING LOG SYMBOLS

Modified California Split Barrel Sampler

Modified California Split Barrel Sampler - No Recovery

Standard Penetration Test (SPT) Sampler

Standard Penetration Test (SPT) Sampler - No Recovery

Perched Water Level

Water Level First Encountered

Water Level After Drilling

Pocket Penetrometer (tsf)

Vane Shear (ksf)

1. The location of borings were approximately determined by pacing and/or siting from visible features. Elevations of borings are approximately determined by interpolating between plan contours. The location and elevation of the borings should be considered.

2. The stratification lines represent the approximate boundary between soil types and the transition may be gradual.

3. Water level readings have been made in the drill holes at times and under conditions stated on the boring logs. This data has been reviewed and interpretations made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, tides, temperature, and other factors at the time measurements were made.

BORING LOG SYMBOLS

Earth Systems

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			*GRAPH SYMBOL*	*LETTER SYMBOL*	*TYPICAL DESCRIPTIONS*
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS <u>LARGER</u> THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION <u>RETAINED</u> ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		**GM**	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION <u>PASSING</u> NO. 4 SIEVE	CLEAN SAND (LITTLE OR NO FINES)		**SW**	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNTOF FINES)		**SM**	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS <u>SMALLER</u> THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT <u>LESS</u> THAN 50		**ML**	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT <u>GREATER</u> THAN 50		**MH**	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				**PT**	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENT

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

UNIFIED SOIL CLASSIFICATION SYSTEM

Earth Systems

APPENDIX B

Laboratory Testing
Tabulated Laboratory Test Results
Individual Laboratory Test Results
Table 18-I-D

LABORATORY TESTING

A. Samples were reviewed along with field logs to determine which would be analyzed further. Those chosen for laboratory analysis were considered representative of soils that would be exposed and/or used during grading, and those deemed to be within the influence of proposed structures. Test results are presented in graphic and tabular form in this Appendix.

B. In-situ Moisture Content and Unit Dry Weight for the ring samples were determined in general accordance with ASTM D 2937.

C. The relative strength characteristics of soils were determined from the results of Direct Shear tests performed on remolded and relatively undisturbed samples. Specimens were placed in contact with water at least 24 hours before testing, and were then sheared under normal loads ranging from 1 to 3 ksf in general accordance with ASTM D 3080.

D. Expansion index tests were performed on bulk soil samples in accordance with ASTM D 4829. The samples were surcharged under 144 pounds per square foot at moisture content of near 50% saturation. The samples were then submerged in water for 24 hours, and the amount of expansion was recorded with a dial indicator.

E. Maximum density tests were performed to estimate the moisture-density relationships of typical soil materials. The tests were performed in accordance with ASTM D 1557.

F. The gradation characteristics of selected samples were evaluated by hydrometer (in accordance with ASTM D 422) and sieve analysis procedures. Selected samples were soaked in water until individual soil particles were separated, then washed on the No. 200 mesh sieve, oven dried, weighed to calculate the percent passing the No. 200 sieve, and mechanically sieved. Additionally, hydrometer analyses were performed to assess the distribution of the minus No. 200 mesh material of the samples. The hydrometer portions of the tests were run using sodium hexametaphosphate as a dispersing agent.

G. A portion of the bulk sample from Boring B-5 was sent to another laboratory for analyses of soil pH, resistivity, chloride contents, and sulfate contents. Soluble chloride and sulfate contents were determined on a dry weight basis. Resistivity testing was performed in accordance with California Test Method 424, wherein the ratio of soil to water was 1:3.

H. The Plasticity Indices of selected samples were evaluated in accordance with ASTM D 4318.

TABULATED LABORATORY TEST RESULTS

	REMOLDED SAMPLES	
BORING AND DEPTH	B-1 @ 0-2’	B-5 @ 0-5’
USCS	ML	SM
MAXIMUM DENSITY (pcf)	120.0	122.0
OPTIMUM MOISTURE (%)	11.0	10.5
COHESION (psf)	220* 70**	190* 120**
ANGLE OF INTERNAL FRICTION	30°* 32°**	33°* 32°**
EXPANSION INDEX	16	6
pH	7.4	8.2
SOLUBLE CHLORIDES (mg/Kg)	8.9	23
RESISTIVITY (OHMs-cm)	6,100	860
SOLUBLE SULFATES (mg/Kg)	21	1,500

* = Peak Strength Parameters; ** = Ultimate Strength Parameters

BORING AND DEPTH	B-1 @ 17’	B-1 @ 30’	B-5 @ 20’	B-5 @ 30’
USCS	MH	CL	ML	CL
IN-PLACE MOISTURE (%)	--	--	54.9	27.0
LIQUID LIMIT	64	42	44	38
PLASTIC LIMIT	34	22	33	22
PLASTICITY INDEX	30	20	11	16
GRAIN SIZE DISTRIBUTION (%)				
GRAVEL	0.0	2.4	0.0	0.0
SAND	13.2	15.4	4.4	12.3
SILT	46.6	42.5	62.0	51.3
CLAY (2ųm to 5ųm)	22.1	10.7	11.8	8.3
CLAY (≤2ųm)	18.1	29.0	21.8	28.1

TABULATED LABORATORY TEST RESULTS (Continued)

REMOLDED SAMPLES

BORING AND DEPTH	B-5 @ 35’	B-5 @ 45’	B-5 @ 50’
USCS	CL	ML	ML/CL
IN-PLACE MOISTURE (%)	28.5	31.8	31.4
LIQUID LIMIT	28	--	36
PLASTIC LIMIT	20	--	25
PLASTICITY INDEX	8	Non-Plastic	11
GRAIN SIZE DISTRIBUTION (%)			
GRAVEL	0.0	0.0	0.0
SAND	33.2	19.6	16.7
SILT	41.4	72.4	60.2
CLAY (2ųm to 5ųm)	6.7	3.2	6.1
CLAY (≤2ųm)	18.7	4.8	17.0

BORING AND DEPTH	B-1 @ 0-2’	B-1 @ 10’	B-1 @ 15’
USCS	ML	SW	SW
GRAIN SIZE DISTRIBUTION (%)			
GRAVEL	0.8	0.5	0.4
SAND	46.8	95.4	91.5
SILT	39.5	3.5	7.0
CLAY (2ųm to 5ųm)	4.3	0.5	0.0
CLAY (≤2ųm)	8.6	0.1	1.1

BORING AND DEPTH	B-1 @ 22’	B-1 @ 26’	B-1 @ 35’
USCS	SW	SM	ML
GRAIN SIZE DISTRIBUTION (%)			
GRAVEL	2.7	0.0	0.3
SAND	86.5	85.7	21.6
SILT	8.8	11.8	57.4
CLAY (2ųm to 5ųm)	0.0	1.2	0.7
CLAY (≤2ųm)	2.0	1.3	20.0

TABULATED LABORATORY TEST RESULTS (Continued)

REMOLDED SAMPLES

BORING AND DEPTH	B-1 @ 40'	B-1 @ 45'	B-1 @ 50'
USCS	ML	ML	CL
GRAIN SIZE DISTRIBUTION (%)			
GRAVEL	0.1	0.0	0.0
SAND	35.5	23.7	18.5
SILT	52.1	64.0	53.2
CLAY (2ųm to 5ųm)	1.7	1.8	1.5
CLAY (≤2ųm)	10.6	10.5	26.8

RELATIVELY UNDISTURBED SAMPLES

BORING AND DEPTH	B-1 @ 5'
USCS	SW
IN-PLACE DENSITY (pcf)	98.5
IN-PLACE MOISTURE (%)	4.8
COHESION (psf)	310* 100**
ANGLE OF INTERNAL FRICTION	33°* 30°**

^ * = Peak Strength Parameters; ** = Ultimate Strength Parameters

TABULATED TEST RESULTS

BORING AND DEPTH	1 @ 0-2'	1 @ 5'
USCS	ML	SW
MAXIMUM DENSITY (pcf)	120.0	--
OPTIMUM MOISTURE (%)	11.0	--
COHESION (psf) (PK./ULT.)	220/70	310/100
ANGLE OF INTERNAL FRICT. (PK./ULT.)	30/32	33/30
EXPANSION INDEX	16	--
pH	7.4	--
RESISTIVITY (ohms-cm)	6,100	--
SOLUBLE SULFATE (mg/kg)	21	--
SOLUBLE CHLORIDE (mg/kg)	8.9	--

BORING AND DEPTH	1@0-2'	1@10'	1@15'	1@17'
GRAIN SIZE DISTRIBUTION (%)				
GRAVEL	0.8	0.5	0.4	0.0
SAND	46.8	95.4	91.5	13.2
SILT	39.5	3.5	7.0	46.6
CLAY (5µm-2µm)	4.3	0.5	0.0	22.1
CLAY (≤2 µm)	8.6	0.1	1.1	18.1

BORING AND DEPTH	1@22'	1@26'	1@30'	1@35'
GRAIN SIZE DISTRIBUTION (%)				
GRAVEL	2.7	0.0	2.4	0.3
SAND	86.5	85.7	15.4	21.6
SILT	8.8	11.8	42.5	57.4
CLAY (5µm-2µm)	0.0	1.2	10.7	0.7
CLAY (≤2 µm)	2.0	1.3	29.0	20.0

TABULATED TEST RESULTS (Continued)

BORING AND DEPTH	1@40'	1@45'	1@50'
GRAIN SIZE DISTRIBUTION (%)			
GRAVEL	0.1	0.0	0.0
SAND	35.5	23.7	18.5
SILT	52.1	64.0	53.2
CLAY (5µm-2µm)	1.7	1.8	1.5
CLAY (≤2 µm)	10.6	10.5	26.8

ATTERBERG LIMITS

BORING AND DEPTH	1@ 17'	1@30'
LIQUID LIMIT	64	42
PLASTIC LIMIT	34	22
PLASTICITY INDEX	30	20

IN-PLACE DENSITIES

BORING & DEPTH	DRY DENSITY (pcf)	MOISTURE (%)
1 @ 1'	113.8	8.3
3'	97.7	6.4
5'	98.5	4.8
7'	94.6	14.6
10'	102.6	20.0
12'	99.8	24.6

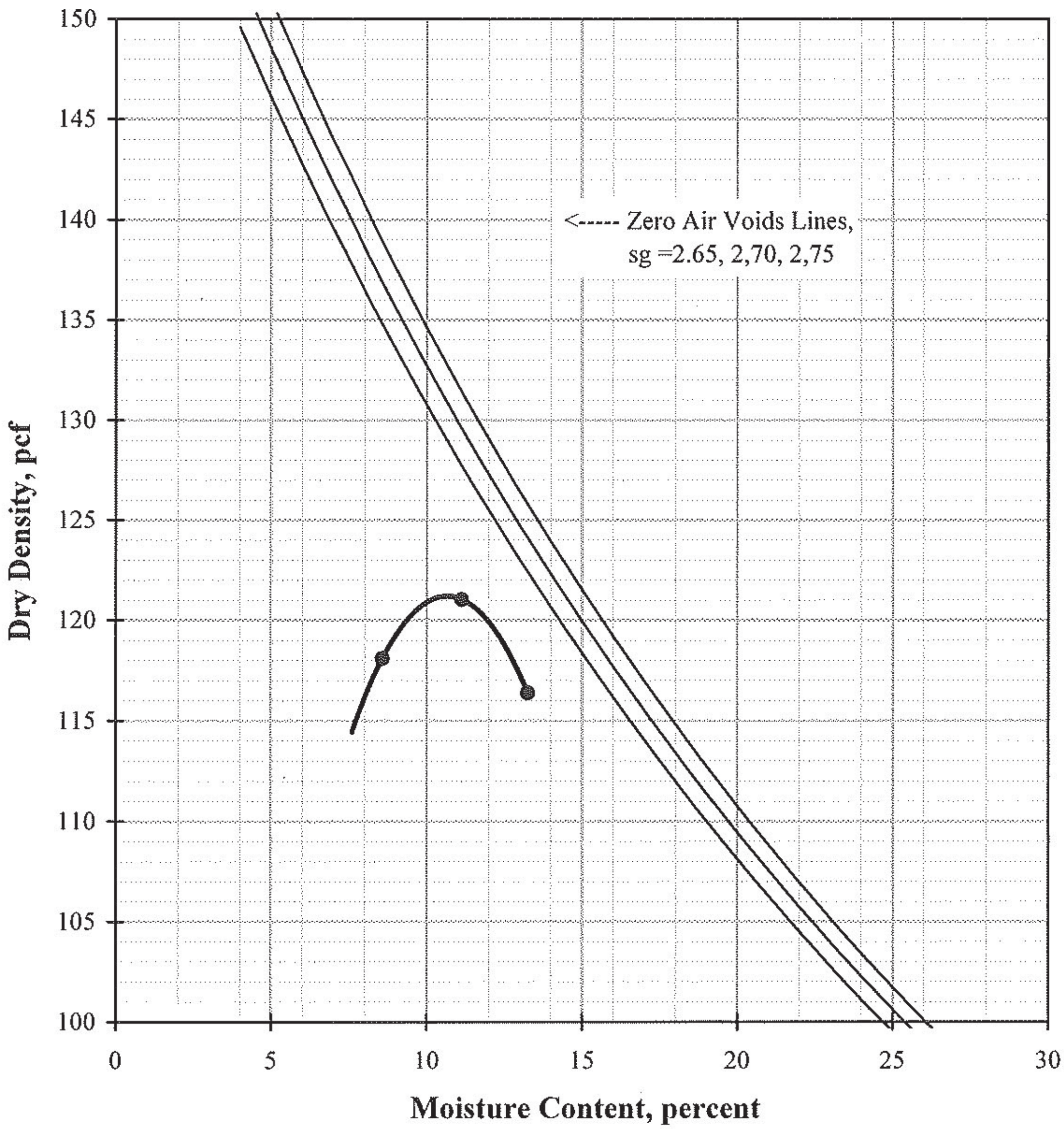
MAXIMUM DENSITY / OPTIMUM MOISTURE ASTM D 1557-91 (Modified)

Job Name: Hueneme High School
Sample ID: B 1 @ 0-2
Location: 0-2'
Description: Dark Brown Silty Sand

Procedure Used: A
Prep. Method: Moist
Rammer Type: Automatic

Maximum Density: **120 pcf**
Optimum Moisture: **11%**

Sieve Size	% Retained
3/4"	0.0
3/8"	0.0
#4	0.8



File Number: 303277-003　　　　Lab Number: 098362

MAXIMUM DENSITY / OPTIMUM MOISTURE

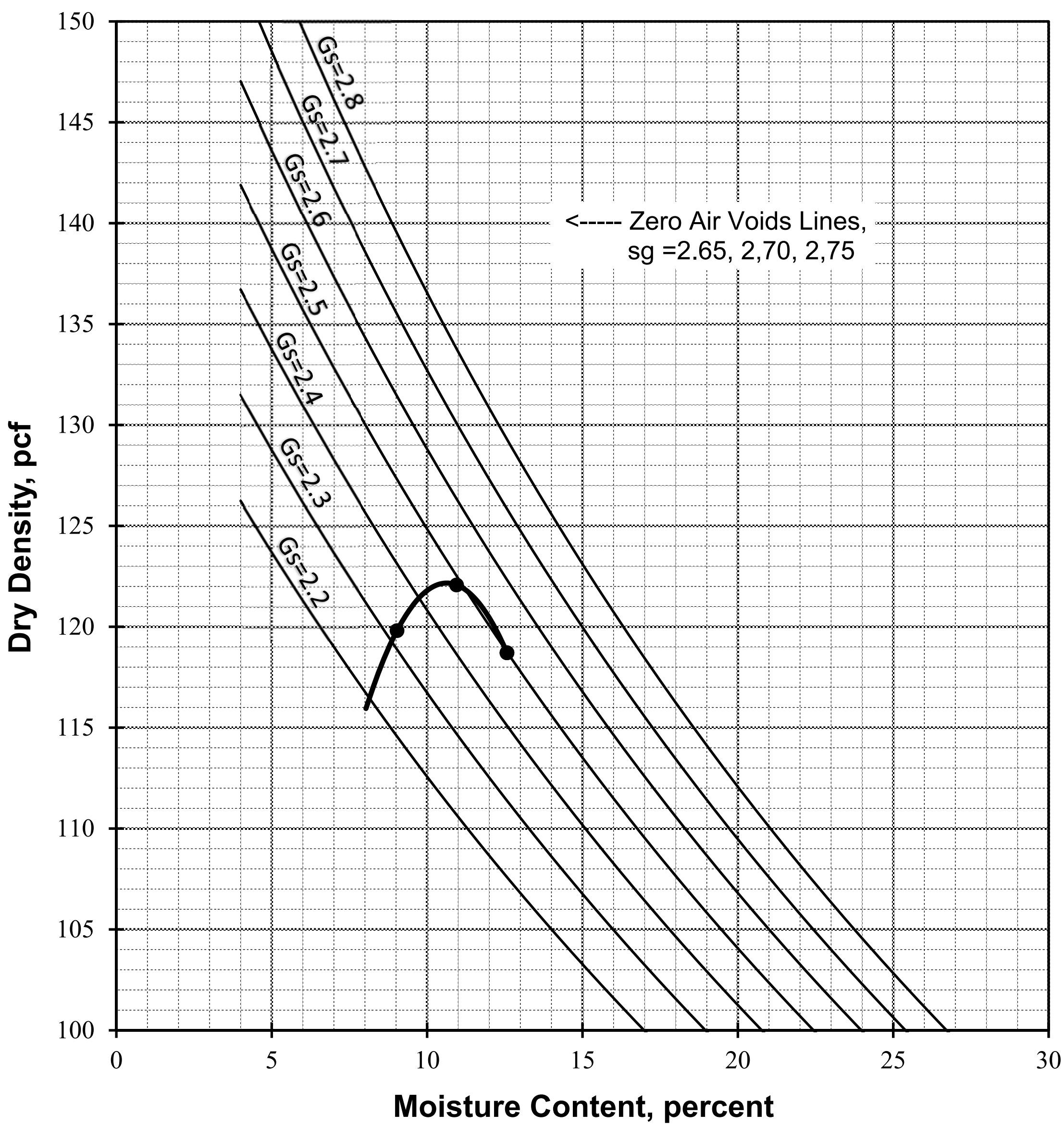
ASTM D 1557-12 (Modified)

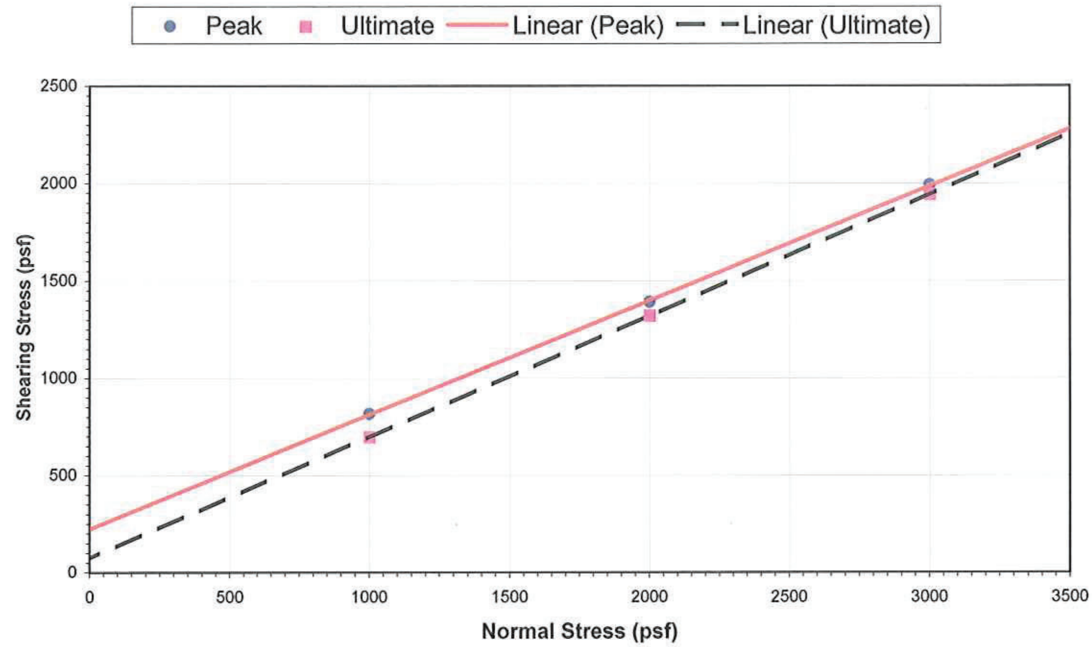
Job Name: Hueneme High School Bleachers　　　　Procedure Used: B
Sample ID: B 5 @ 0-5'　　　　Prep. Method: Moist

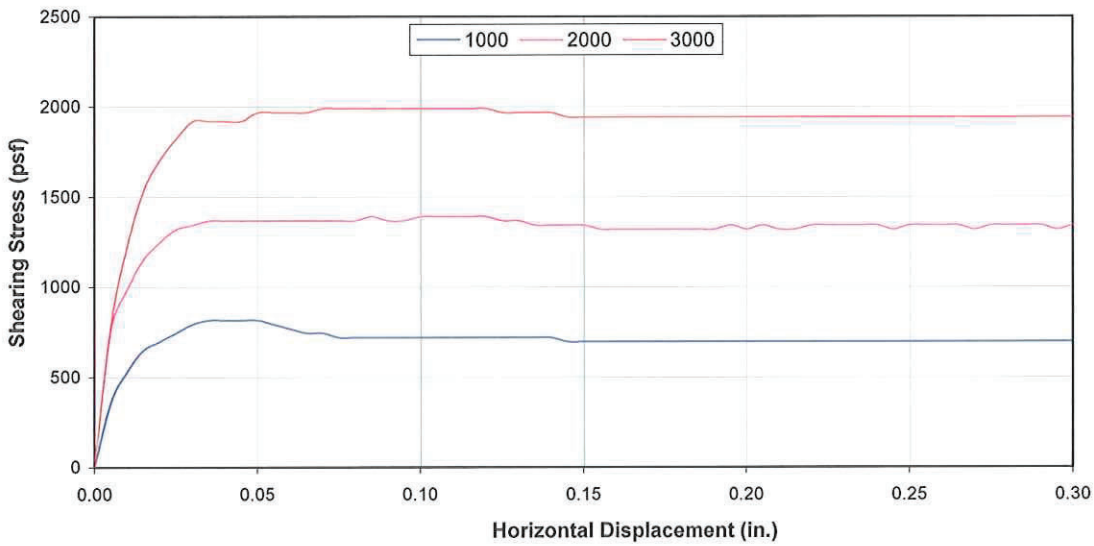
Date: 1/29/2020　　　　Rammer Type: Automatic
Description: Dark Brown Silty Sand
SG: 2.47

Maximum Density: **122 pcf**
Optimum Moisture: **10.5%**

Sieve Size	% Retained
3/4"	0.0
3/8"	0.7
#4	0.0







DIRECT SHEAR DATA*

Sample Location: B 1 @ 0'-2'
Sample Description: Silty Sand Sandy Silt
Dry Density (pcf): 107.5
Intial % Moisture: 10.8
Average Degree of Saturation: 95.2
Shear Rate (in/min): 0.0189 in/min

Normal stress (psf)	1000	2000	3000
Peak stress (psf)	816	1392	1992
Ultimate stress (psf)	696	1320	1944

	Peak	Ultimate
ϕ Angle of Friction (degrees):	30	32
c Cohesive Strength (psf):	220	70

Test Type: Peak & Ultimate

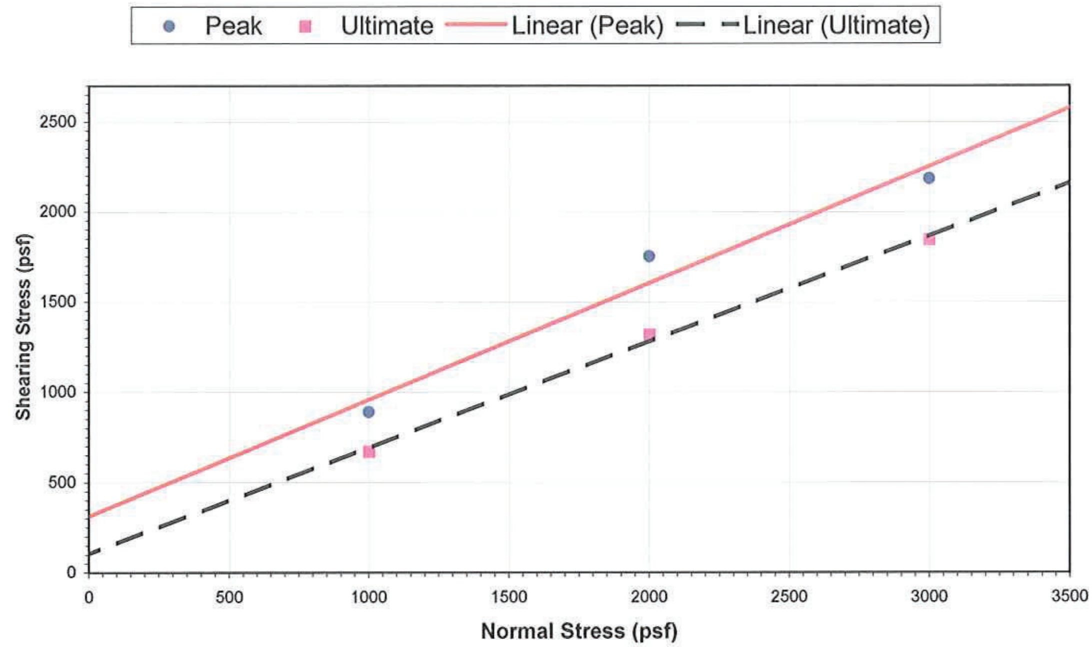
* Test Method: ASTM D-3080

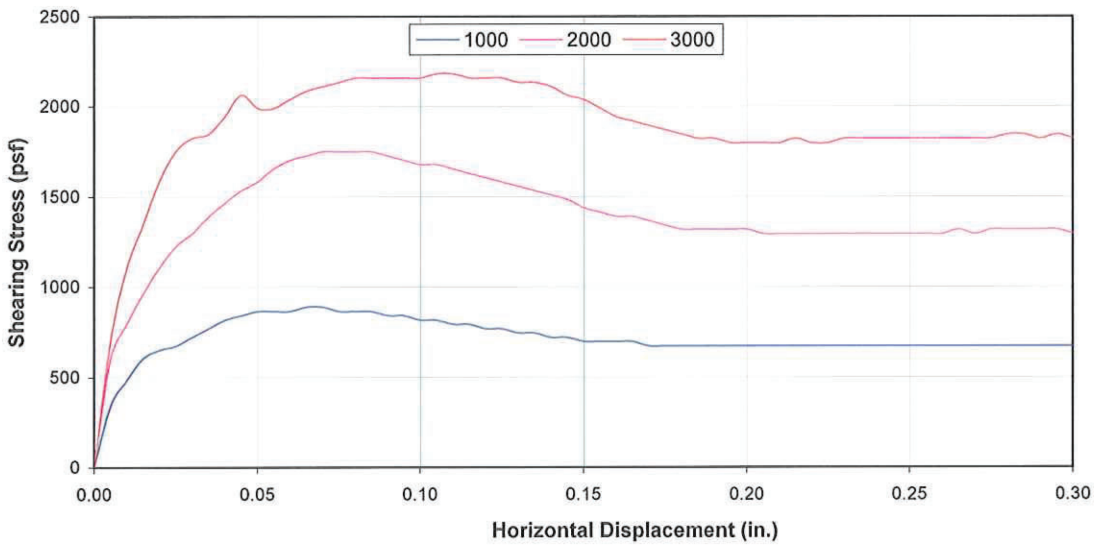
DIRECT SHEAR TEST

Hueneme High Bleachers

Earth Systems
Southern California

1/12/2010 | VT-23434-03





DIRECT SHEAR DATA*

Sample Location: B 1 @ 5'
Sample Description: Silty Poorly Graded Sand
Dry Density (pcf): 98.5
Intial % Moisture: 4.8
Average Degree of Saturation: 88.5
Shear Rate (in/min): 0.0156 in/min

Normal stress (psf)	1000	2000	3000
Peak stress (psf)	888	1752	2184
Ultimate stress (psf)	672	1320	1848

	Peak	Ultimate
ϕ Angle of Friction (degrees):	33	30
c Cohesive Strength (psf):	310	100

Test Type: Peak & Ultimate

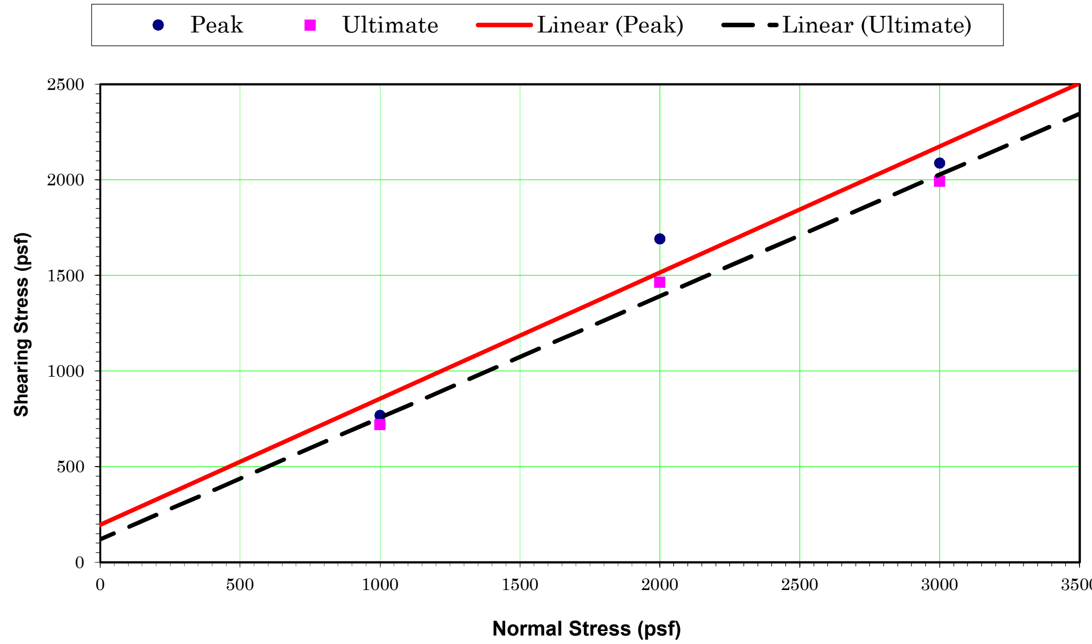
* Test Method: ASTM D-3080

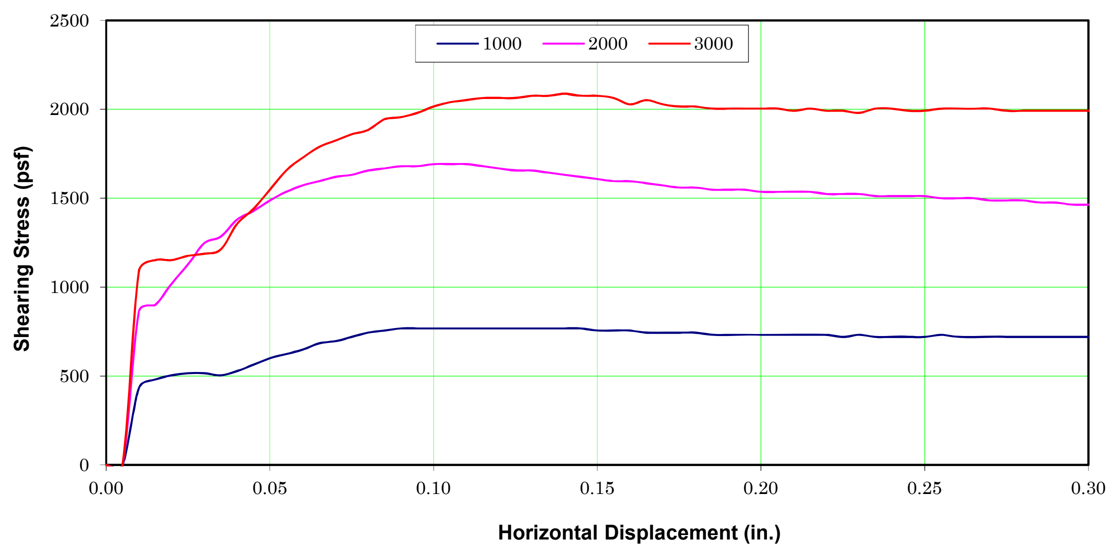
DIRECT SHEAR TEST

Hueneme High Bleachers

Earth Systems
Southern California

1/12/2010 | VT-23434-03





DIRECT SHEAR DATA*

Sample Location: B 5 @ 0-5'
Sample Description: Silty Sand
Dry Density (pcf): 110.4
Intial % Moisture: 10.6
Average Degree of Saturation: 100.0
Shear Rate (in/min): 0.005 in/min

Normal stress (psf)	1000	2000	3000
Peak stress (psf)	768	1692	2088
Ultimate stress (psf)	720	1464	1992

	Peak	Ultimate
ϕ Angle of Friction (degrees):	33	32
c Cohesive Strength (psf):	190	120

Test Type: Peak & Ultimate

* Test Method: ASTM D-3080

DIRECT SHEAR TEST

Hueneme High School Bleachers

Earth Systems

2/11/2020 | 303277-003

File No.: VT-23434-03 January 12, 2010

EXPANSION INDEX

ASTM D-4829, UBC 18-2

Job Name: Hueneme High Bleachers
Sample ID: B1 @ 0'-2'
Soil Description: SM/ML

Initial Moisture, %:	9.7
Initial Compacted Dry Density, pcf:	110.6
Initial Saturation, %:	50
Final Moisture, %:	20.9
Volumetric Swell, %:	1.6

Expansion Index: 16 Very Low

EI	UBC Classification
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
130+	Very High

File No.: 303277-003

EXPANSION INDEX

ASTM D-4829, UBC 18-2

Job Name: Hueneme High School Bleachers
Sample ID: B 5 @ 0-5'
Soil Description: SM

Initial Moisture, %:	9.5
Initial Compacted Dry Density, pcf:	110.3
Initial Saturation, %:	49
Final Moisture, %:	20.7
Volumetric Swell, %:	0.6

Expansion Index: **6** **Very Low**

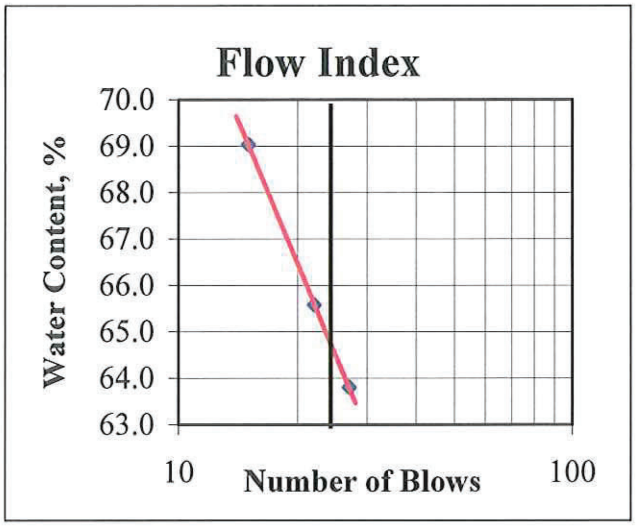
EI	UBC Classification
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
130+	Very High

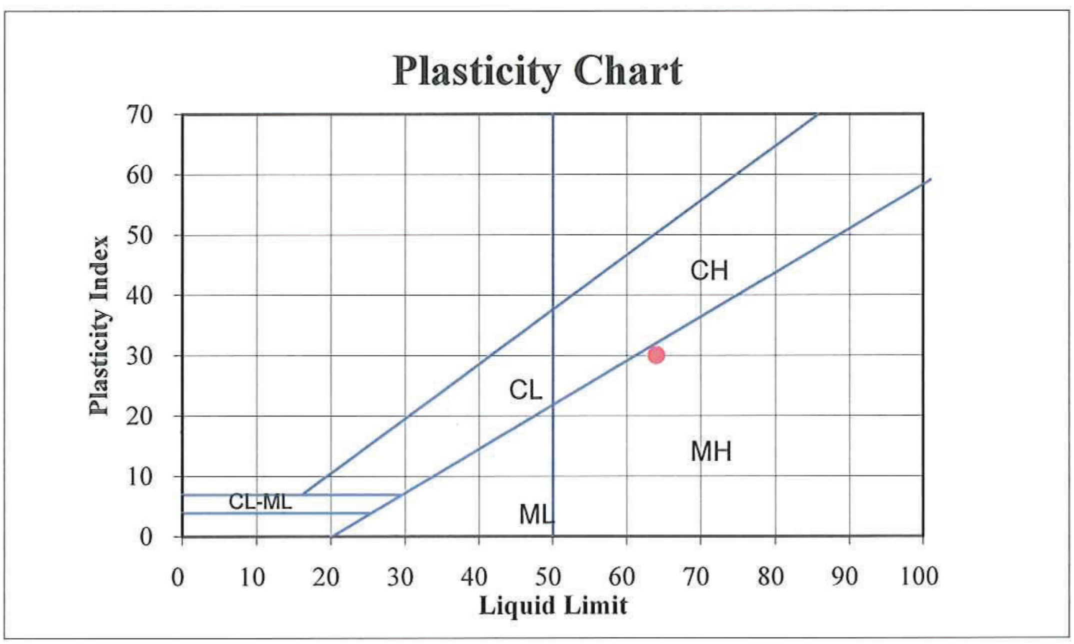
PLASTICITY INDEX

ASTM D-4318

Job Name: Hueneme High Bleachers
Sample ID: B1 @ 17'
Soil Description: MH

DATA SUMMARY				TEST RESULTS	
Number of Blows:	15	22	27	**LIQUID LIMIT**	**64**
Water Content, %	69.0	65.6	63.8	**PLASTIC LIMIT**	**34**
Plastic Limit:	33.8	33.7		**PLASTICITY INDEX**	**30**



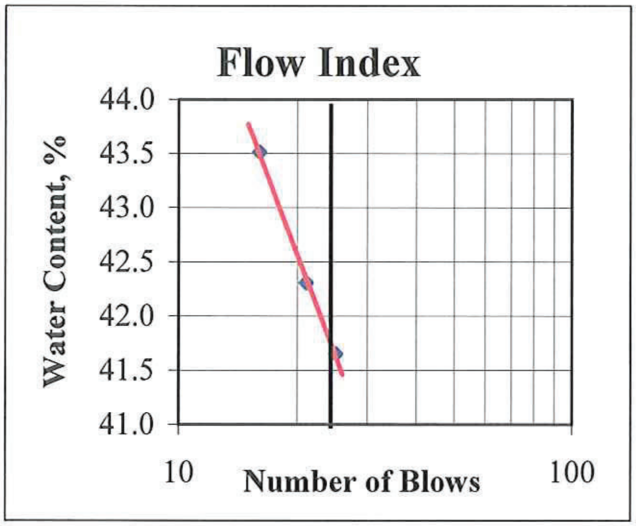


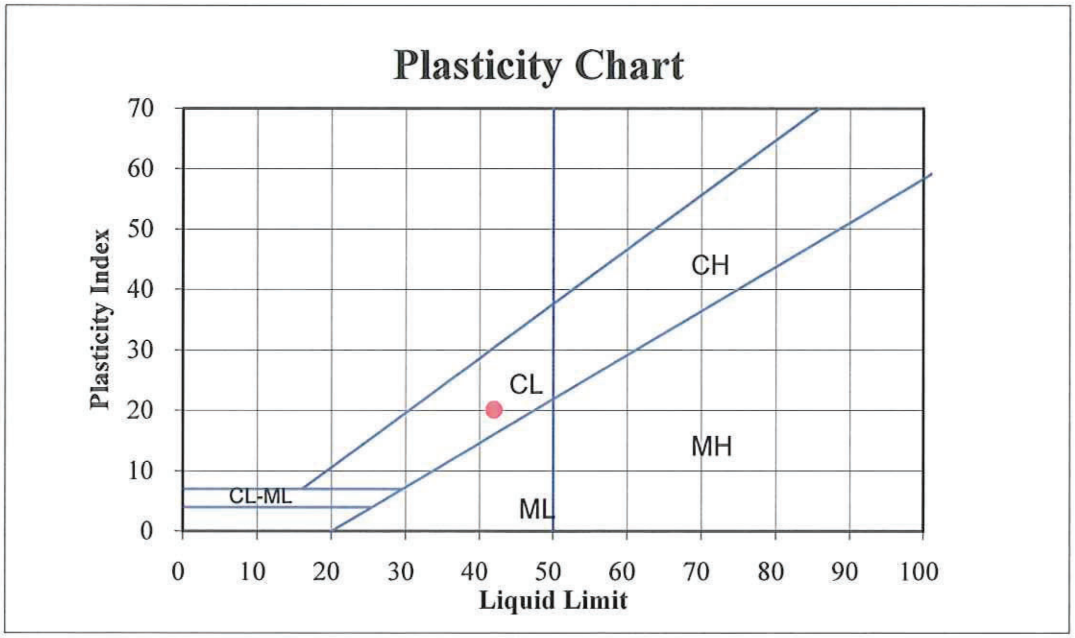
PLASTICITY INDEX

ASTM D-4318

Job Name: Hueneme High Bleachers
Sample ID: B1 @ 30'
Soil Description: CL/ML

DATA SUMMARY				TEST RESULTS	
Number of Blows:	16	21	25	**LIQUID LIMIT**	**42**
Water Content, %	43.5	42.3	41.7	**PLASTIC LIMIT**	**22**
Plastic Limit:	22.3	22.2		**PLASTICITY INDEX**	**20**



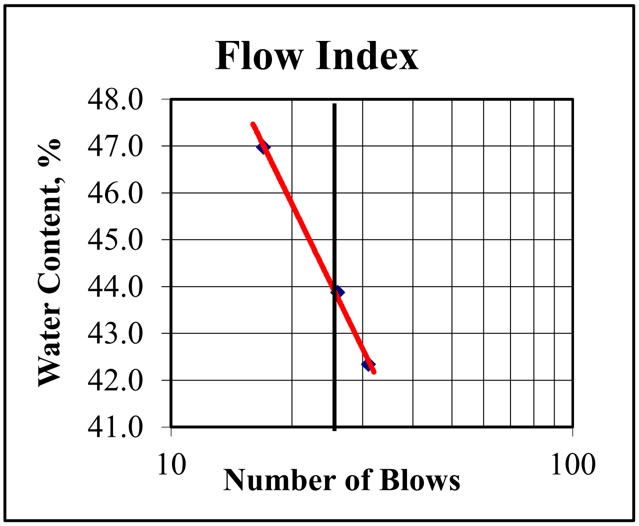


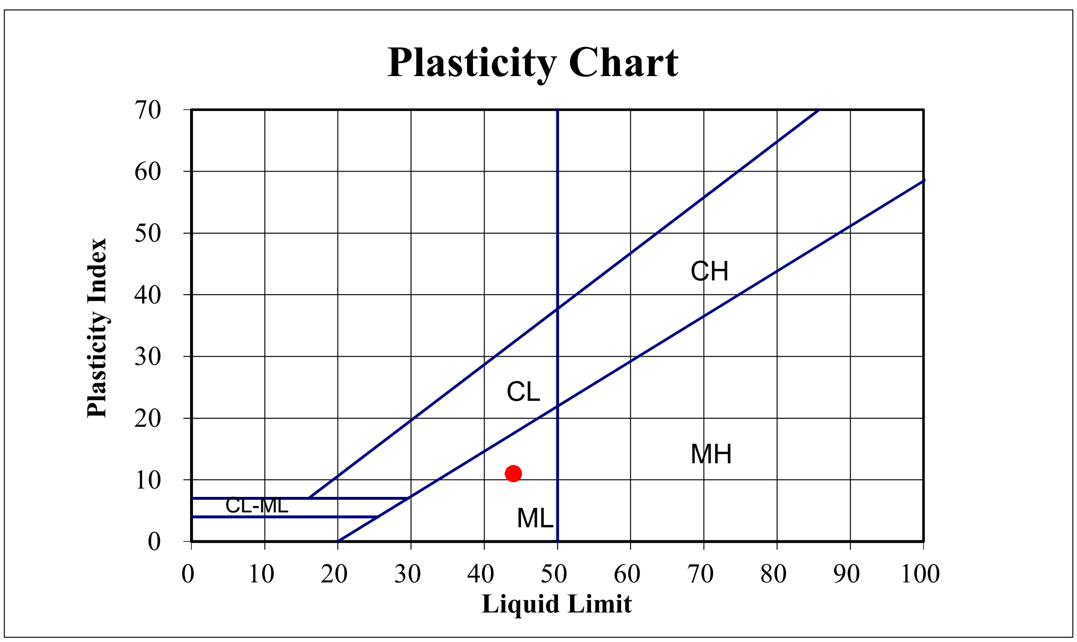
PLASTICITY INDEX

ASTM D-4318

Job Name: Hueneme High School Bleachers
Sample ID: B 5 @ 20'
Soil Description: ML

DATA SUMMARY				TEST RESULTS	
Number of Blows:	17	26	31	**LIQUID LIMIT**	**44**
Water Content, %	47.0	43.9	42.3	**PLASTIC LIMIT**	**33**
Plastic Limit:	33.5	33.5		**PLASTICITY INDEX**	**11**



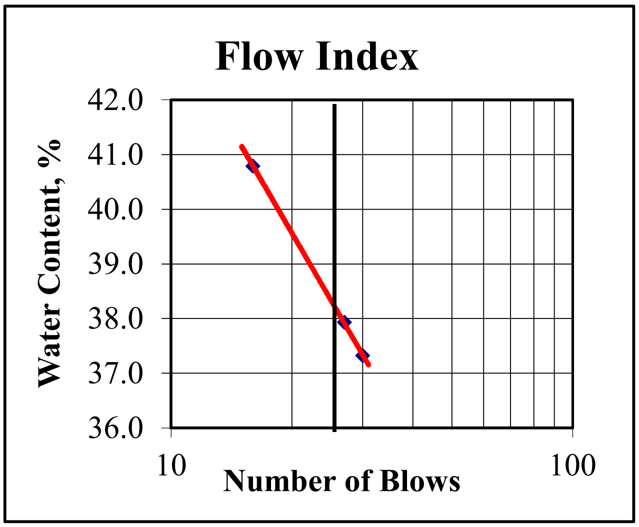


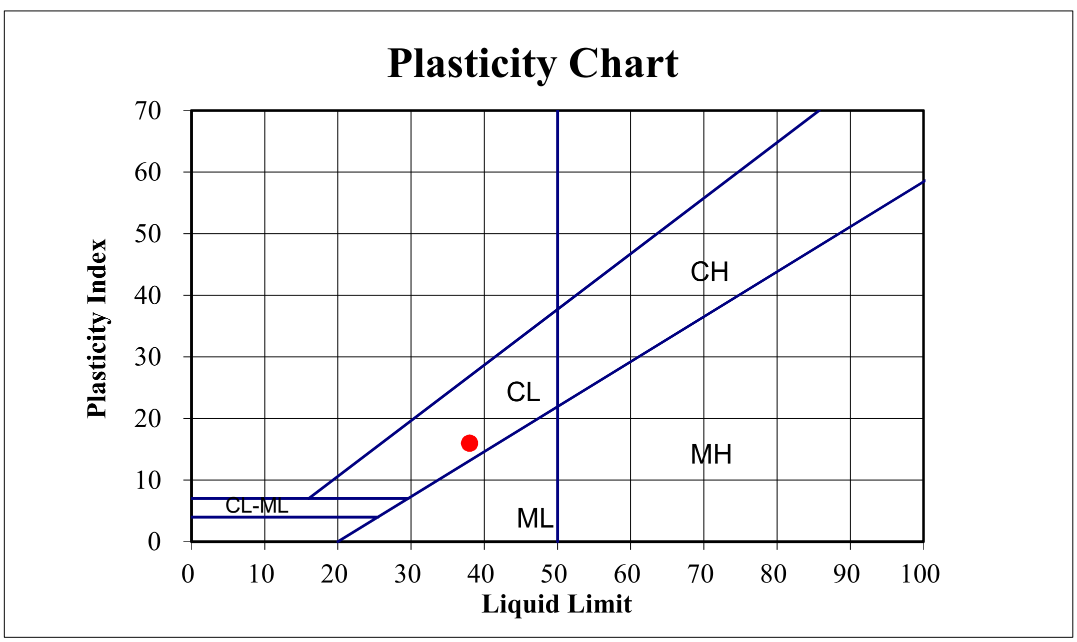
PLASTICITY INDEX

ASTM D-4318

Job Name: Hueneme High School Bleachers
Sample ID: B 5 @ 30'
Soil Description: CL

DATA SUMMARY				TEST RESULTS	
Number of Blows:	16	27	30	**LIQUID LIMIT**	**38**
Water Content, %	40.8	37.9	37.3	**PLASTIC LIMIT**	**22**
Plastic Limit:	22.2	22.0		**PLASTICITY INDEX**	**16**





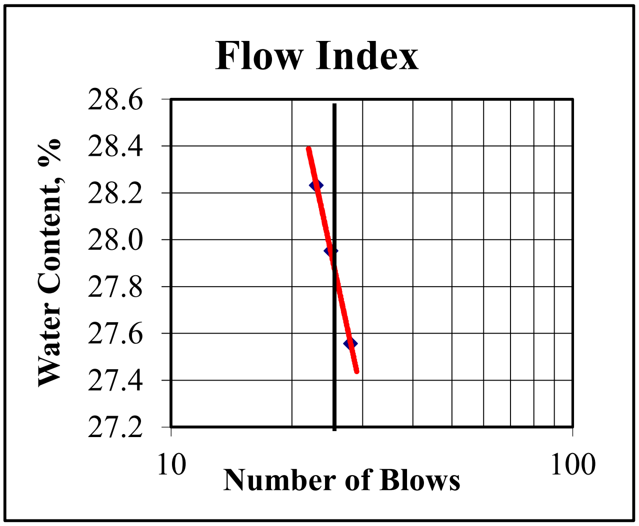
PLASTICITY INDEX

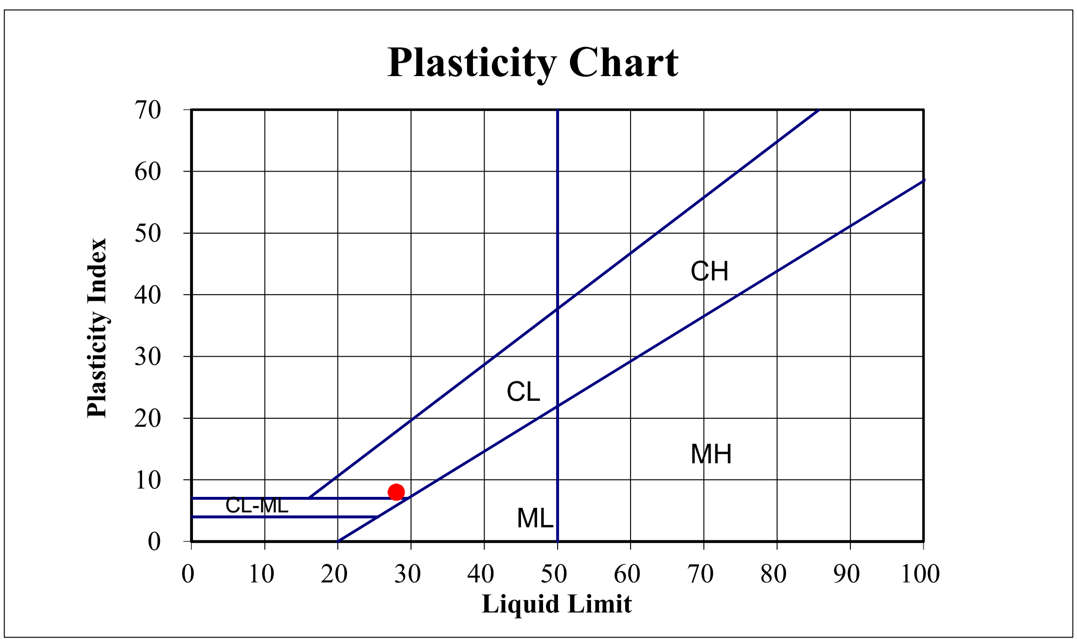
ASTM D-4318

Job Name: Hueneme High School Bleachers
Sample ID: B 5 @ 35'
Soil Description: CL

DATA SUMMARY **TEST RESULTS**

Number of Blows:	23	25	28	**LIQUID LIMIT**	**28**
Water Content, %	28.2	28.0	27.6	**PLASTIC LIMIT**	**20**
Plastic Limit:	20.0	20.6		**PLASTICITY INDEX**	**8**





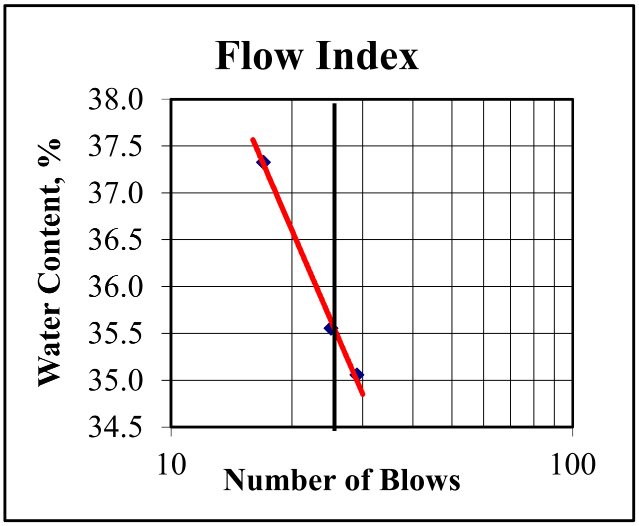
File No.: 303277-003 February 9, 2020

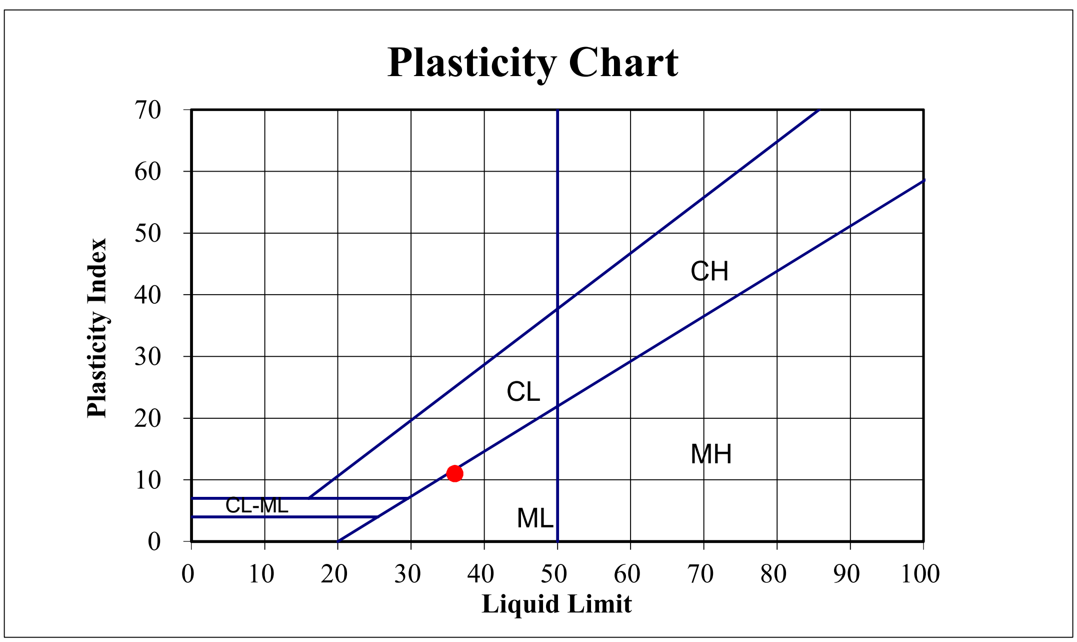
PLASTICITY INDEX

ASTM D-4318

Job Name: Hueneme High School Bleachers
Sample ID: B 5 @ 50'
Soil Description: ML/CL

DATA SUMMARY				TEST RESULTS	
Number of Blows:	17	25	29	**LIQUID LIMIT**	**36**
Water Content, %	37.3	35.6	35.1	**PLASTIC LIMIT**	**25**
Plastic Limit:	25.1	24.6		**PLASTICITY INDEX**	**11**





MECHANICAL ANALYSIS

CTM 203-08

Job Name:	Hueneme High School Bleachers
Job No.:	303277-003
Sample ID:	**B 5 @ 20'**
Soil Description:	**ML**
Hydrometer ID:	504229

Hydroscopic Moisture

Air Dry Wt, g:	100.0
Oven Dry Wt, g	100.0
% Moisture:	0.0

Air Dry Sample Wt., g:	311.2
Corrected Wt., g:	311.2

Sieve Analysis for +#10 Material

Sieve Size	Wt Ret	% Ret	% Passing
1/2 inch	0.0	0.00	100.00
3/8 inch	0.0	0.00	100.00
#4	0.0	0.00	100.00
#8	0.0	0.00	100.00
#10	0.0	0.00	100.00

Air Dry Hydro Sample Wt., g:	59.6
Corrected Wt., g:	59.6
Calculation Factor	0.5960

Hydrometer Analysis for <#10 Material

Start time: 3:53:00 AM

Short Hydro	Time of Reading	Hydro Reading	Temp. at Reading, °C	Correction Factor	Corrected Hydro Reading
20 sec	3:53:20 AM	63	15	6.0	57.0
1 hour	4:53:00 AM	26	15	6.0	20.0
6 hour	9:53:00 AM	19	15	6.0	13.0

% Gravel:	0.0
% Sand(2mm - 74µm):	4.4
% Silt(74µm- 5µm):	62.0
% Clay(5µm - 2µm):	11.8
% Clay(≤2µm):	21.8

MECHANICAL ANALYSIS

CTM 203-08

Job Name:	Hueneme High School Bleachers
Job No.:	303277-003
Sample ID:	**B 5 @ 30'**
Soil Description:	**CL**
Hydrometer ID:	504229

Hydroscopic Moisture

Air Dry Wt, g:	100.0
Oven Dry Wt, g	100.0
% Moisture:	0.0
Air Dry Sample Wt., g:	484.4
Corrected Wt., g:	484.4

Sieve Analysis for +#10 Material

Sieve Size	Wt Ret	% Ret	% Passing
1/2 inch	0.0	0.00	100.00
3/8 inch	0.0	0.00	100.00
#4	0.0	0.00	100.00
#8	0.0	0.00	100.00
#10	0.0	0.00	100.00

Air Dry Hydro Sample Wt., g:	60.4
Corrected Wt., g:	60.4
Calculation Factor	0.6040

Hydrometer Analysis for <#10 Material

Start time: 4:05:00 AM

Short Hydro	Time of Reading	Hydro Reading	Temp. at Reading, °C	Correction Factor	Corrected Hydro Reading
20 sec	4:05:20 AM	59	15	6.0	53.0
1 hour	5:05:00 AM	28	15	6.0	22.0
6 hour	10:05:00 AM	23	15	6.0	17.0

% Gravel:	0.0
% Sand(2mm - 74µm):	12.3
% Silt(74µm- 5µm):	51.3
% Clay(5µm - 2µm):	8.3
% Clay(≤2µm):	28.1

MECHANICAL ANALYSIS

CTM 203-08

Job Name:	Hueneme High School Bleachers
Job No.:	303277-003
Sample ID:	**B 5 @ 35'**
Soil Description:	**CL**
Hydrometer ID:	504229

Hydroscopic Moisture

Air Dry Wt, g:	100.0
Oven Dry Wt, g	100.0
% Moisture:	0.0

Air Dry Sample Wt., g:	615.6
Corrected Wt., g:	615.6

Sieve Analysis for +#10 Material

Sieve Size	Wt Ret	% Ret	% Passing
1/2 inch	0.0	0.00	100.00
3/8 inch	0.0	0.00	100.00
#4	0.0	0.00	100.00
#8	0.0	0.00	100.00
#10	0.0	0.00	100.00

Air Dry Hydro Sample Wt., g:	74.9
Corrected Wt., g:	74.9
Calculation Factor	0.7490

Hydrometer Analysis for <#10 Material

Start time: 3:59:00 AM

Short Hydro	Time of Reading	Hydro Reading	Temp. at Reading, °C	Correction Factor	Corrected Hydro Reading
20 sec	3:59:20 AM	56	15	6.0	50.0
1 hour	4:59:00 AM	25	15	6.0	19.0
6 hour	9:59:00 AM	20	15	6.0	14.0

% Gravel:	0.0
% Sand(2mm - 74µm):	33.2
% Silt(74µm- 5µm):	41.4
% Clay(5µm - 2µm):	6.7
% Clay(≤2µm):	18.7

MECHANICAL ANALYSIS

CTM 203-08

Job Name:	Hueneme High School Bleachers
Job No.:	303277-003
Sample ID:	**B 5 @ 45'**
Soil Description:	**ML**
Hydrometer ID:	504229

Hydroscopic Moisture

Air Dry Wt, g:	100.0
Oven Dry Wt, g	100.0
% Moisture:	0.0

Air Dry Sample Wt., g:	359.5
Corrected Wt., g:	359.5

Sieve Analysis for +#10 Material

Sieve Size	Wt Ret	% Ret	% Passing
1/2 inch	0.0	0.00	100.00
3/8 inch	0.0	0.00	100.00
#4	0.0	0.00	100.00
#8	0.0	0.00	100.00
#10	0.0	0.00	100.00

Air Dry Hydro Sample Wt., g:	62.2
Corrected Wt., g:	62.2
Calculation Factor	0.6220

Hydrometer Analysis for <#10 Material

Start time: 3:55:00 AM

Short Hydro	Time of Reading	Hydro Reading	Temp. at Reading, °C	Correction Factor	Corrected Hydro Reading
20 sec	3:55:20 AM	56	15	6.0	50.0
1 hour	4:55:00 AM	11	15	6.0	5.0
6 hour	9:55:00 AM	9	15	6.0	3.0

% Gravel:	0.0
% Sand(2mm - 74µm):	19.6
% Silt(74µm- 5µm):	72.4
% Clay(5µm - 2µm):	3.2
% Clay(≤2µm):	4.8

MECHANICAL ANALYSIS

CTM 203-08

Job Name:	Hueneme High School Bleachers
Job No.:	303277-003
Sample ID:	**B 5 @ 50'**
Soil Description:	**ML/CL**
Hydrometer ID:	504229

Hydroscopic Moisture

Air Dry Wt, g:	100.0
Oven Dry Wt, g	100.0
% Moisture:	0.0
Air Dry Sample Wt., g:	543
Corrected Wt., g:	543.0

Sieve Analysis for +#10 Material

Sieve Size	Wt Ret	% Ret	% Passing
1/2 inch	0.0	0.00	100.00
3/8 inch	0.0	0.00	100.00
#4	0.0	0.00	100.00
#8	0.0	0.00	100.00
#10	0.0	0.00	100.00

Air Dry Hydro Sample Wt., g:	64.8
Corrected Wt., g:	64.8
Calculation Factor	0.6480

Hydrometer Analysis for <#10 Material

Start time: 4:00:00 AM

Short Hydro	Time of Reading	Hydro Reading	Temp. at Reading, °C	Correction Factor	Corrected Hydro Reading
20 sec	4:00:20 AM	60	15	6.0	54.0
1 hour	5:00:00 AM	21	15	6.0	15.0
6 hour	10:00:00 AM	17	15	6.0	11.0

% Gravel:	0.0
% Sand(2mm - 74µm):	16.7
% Silt(74µm- 5µm):	60.2
% Clay(5µm - 2µm):	6.1
% Clay(≤2µm):	17.0

CERTIFICATE OF ANALYSIS

Client: Earth Systems Pacific
CAS LAB NO: 200117-01
Sample ID: B1@0-5'
Analyst: GP

Date Sampled: 01/15/20
Date Received: 01/17/20
Sample Matrix: Soil

WET CHEMISTRY SUMMARY

COMPOUND	RESULTS	UNITS	DF	PQL	METHOD	ANALYZED
pH (Corrosivity)	8.2	S.U.	1	---	9045	01/23/20
Resistivity*	860	Ohms-cm	1	---	SM 120.1M	01/23/20
Chloride	23	mg/Kg	1	0.3	300.0M	01/24/20
Sulfate	1500	mg/Kg	1	0.3	300.0M	01/24/20

*Sample was extracted using a 1:3 ratio of soil and DI water.

DF: Dilution Factor
PQL: Practical Quantitation Limit
BQL: Below Quantitation Limit
mg/Kg: Milligrams/Kilograms(ppm)

TABLE 18-I-D
MINIMUM FOUNDATION REQUIREMENTS

(Numbers within parenthesis ( ) are footnotes. Refer to the following pages footnotes (1) through (8)

WEIGHTED EXPANSION INDEX	NUMBER OF FLOORS	STEM THICKNESS (inches)	FOOTING WIDTH (inches)	FOOTING THICKNESS (inches)	ALL PERIMETER FOOTINGS (5): DEPTH BELOW NATURAL SURFACE OF GROUND AND FINISH GRADE (3) (8) (inches)	INTERIOR FOOTINGS FOR SLAB AND RAISED FLOORS (5): DEPTH BELOW NATURAL SURFACE OF GROUND AND FINISH GRADE (3) (8) (inches)	REINFORCEMENT FOR CONTINUOUS FOUNDATIONS (2)	CONCRETE SLABS 3 ½ " MINIMUM THICKNESS: REINFORCEMENT (3)	CONCRETE SLABS 3 ½ " MINIMUM THICKNESS: TOTAL THICKNESS OF SAND	PREMOISTENING OF SOILS UNDER FOOTINGS, PIERS AND SLABS (1)	RESTRICTIONS ON PIERS UNDER RAISED FLOORS (A design by a registered structural engineer may be excepted when approved by the Building Official)
0-20 Very low (nonexpansive)	1 2 3	8 8 10	12 15 18	8 7 8	12 18 24	12 18 24	1-#4 top and bottom	6x6-10/10 WWF	2"	Moistening of ground recommended prior to placing concrete.	Piers allowed for single floor loads only
21-50 Low	1 2 3	8 8 10	12 15 18	6 7 8	15 18 24	12 18 24	1-#4 top and bottom	6x6-10/10 WWF	4"	120% of optimum moisture required to a depth of 21" below lowest adjacent grade. Testing required.	Piers allowed for single floor loads only.
51-90 Medium	1 2 3	8 8 10	12 15 18	8 8 8	21 21 24	12 18 24	1-#4 top and bottom #3 BARS @ 24" IN EXT. FOOTING BEND3' INTO SLAB (7)	6x6-10/10 WWF	4"	130% of optimum moisture required to a depth of 27" below lowest adjacent grade. Testing required.	Piers not allowed.
91-130 High	1 2 3	8 8 10	12 15 18	8 8 8	27 27 24	12 18 24	1-#5 top and bottom #3 BARS @ 24" IN EXT. FOOTING BEND 3' INTO SLAB (7)	6x6-10/10 or #3 @ 24' E.W.	4"	140% of optimum moisture required of a depth of 33" below lowest adjacent grade. Testing required	Piers not allowed.
Above 130 Very High	Special design by licensed engineer/architect										

APPENDIX C

Site Class Determination Calculations
2019 CBC & ASCE 7-16 Seismic Parameters
US Seismic Design Maps
Spectral Response Values Table
Fault Parameters

Earth Systems	Job Number:	303277-003
	Job Name:	HHS Bleachers
	Calc Date:	2/6/2020
	CPT/Boring ID:	B-1

Use "SPT N_{60}" if correlated from CPT.
Use "Raw SPT blow/ft" if from SPT/ModCal.
Input Number Max Limit = 100.

↓

Depth (ft)	SPT N	Sublayer Thick (ft)	Sublayer Thick/N
5.0	14.0	5.0	0.357
7.5	9.0	2.5	0.278
10.0	12.0	2.5	0.208
12.5	23.0	2.5	0.109
15.0	22.0	2.5	0.114
17.5	21.0	2.5	0.119
20.0	3.0	2.5	0.833
22.5	17.0	2.5	0.147
25.0	36.0	2.5	0.069
27.5	37.0	2.5	0.068
30.0	8.0	2.5	0.313
32.5	11.0	2.5	0.227
35.0	16.0	2.5	0.156
37.5	10.0	2.5	0.250
40.0	21.0	2.5	0.119
42.5	26.0	2.5	0.096
45.0	21.0	2.5	0.119
47.5	27.0	2.5	0.093
50.0	14.0	2.5	0.179
100.0	25.0	50.0	2.000

Total Thickness of Soil =	100.00	ft
N-bar Value =	17.1	*
Site Classification =	Class D	

*Equation 20.4-2 of ASCE 7-10

2019 California Building Code (CBC) (ASCE 7-16) Seismic Design Parameters

(Values presented should only be used by a Structural Engineer to determine if the exception in 11.4.8 (ASCE 7-16) can be used)

			CBC Reference	ASCE 7-16 Reference
Seismic Design Category		**D**		
Site Class		**D**	Table 1613.5.6	Table 11.6-1
Latitude:		34.157 N	Table 1613.5.2	Table 20.3-1
Longitude:		-119.182 W		
Maximum Considered Earthquake (MCE) Ground Motion				
Short Period Spectral Reponse	S_S	**1.593 g**	Figure 1613.5	Figure 22-1
1 second Spectral Response	S_1	**0.584 g**	Figure 1613.5	Figure 22-2
Site Coefficient	F_a	1.00	Table 1613.5.3(1)	Table 11.4-1
Site Coefficient	F_v	1.72	Table 1613.5.3(2)	Table 11-4.2
	S_{MS}	1.593 g	$= F_a*S_S$	
	S_{M1}	1.002 g	$= F_v*S_1$	
Design Earthquake Ground Motion				
Short Period Spectral Reponse	S_{DS}	**1.062 g**	$= 2/3*S_{MS}$	
1 second Spectral Response	S_{D1}	**0.668 g**	$= 2/3*S_{M1}$	

Site Specific Evaluation May Be Required Due to Site Class = D or E and S1>=0.2. The Presented SDS and SD1 are NOT Valid Unless the Exception of ASCE7-16, Section 11.4.8 Applies

To	0.13 sec	$= 0.2*S_{D1}/S_{DS}$
Ts (11.4.8 ASCE 7-16 Exception Assumed)	0.63 sec	$= S_{D1}/S_{DS}$
Risk Category	III	Table 1604.5
Seismic Importance Factor	1.25	
F_{PGA}	1.10	
PGA_M	**0.76**	
Vertical Coefficient (C_V)	1.42	Table 11.9-1

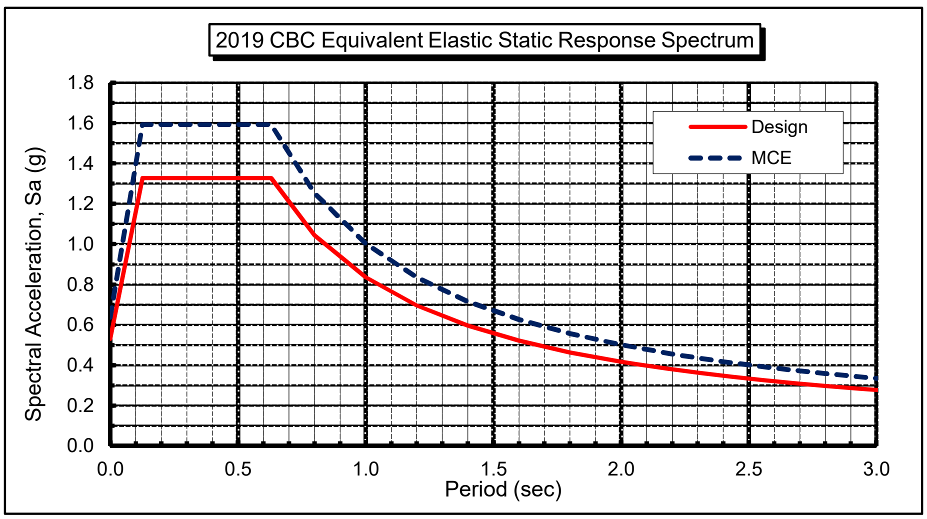


Table 11.5-1 Design

Period T (sec)	Sa (g)
0.00	0.531
0.05	0.848
0.13	1.328
0.63	1.328
0.80	1.044
1.00	0.835
1.20	0.696
1.40	0.597
1.60	0.522
1.80	0.464
2.00	0.418
2.20	0.380
2.40	0.348
2.60	0.321
2.80	0.298
3.00	0.278

Hueneme High School Home Bleachers

Latitude, Longitude: 34.1573, -119.1820

Date	2/6/2020, 8:01:52 AM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.593	MCE_R ground motion. (for 0.2 second period)
S_1	0.584	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.593	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.062	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category
F_a	1	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.689	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.758	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.593	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.783	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.118	Factored deterministic acceleration value. (0.2 second)
S1RT	0.584	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.656	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.639	Factored deterministic acceleration value. (1.0 second)
PGAd	0.839	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.893	Mapped value of the risk coefficient at short periods
C_{R1}	0.889	Mapped value of the risk coefficient at a period of 1 s

34.1573 -119.182 Lat/Long

Spectral Response Values
Probabilistic and Deterministic Response Spectra for MCE compared to Code Spectra
for 5% Viscous Damping Ratio

Natural Period T (seconds)	GeoMean Probab. 2% in 50 year MCE Spectrum (1) 2475-year (ASCE 21.2.1)	Max Rotated Probab. 2% in 50 year MCEr Spectrum (2) 2475-year (ASCE 21.2.1.1)	Max 84th Percentile Determ. MCE Spectrum (3) 1.5*Fa = 1.500 (ASCE 21.2.2)	Determ. Lower Limit MCE Spectrum (4) (3) * 1.00=Scaling (ASCE 21.2.2)	Determ. MCE Spectrum (5) Max (3),(4) (ASCE 21.2.2)	Site Specific MCE Ground Response (6) Min (2),(5) (ASCE 21.2.3)	Site Specific MCE Spectrum Comparator (6b) Max (6),1.5*(8) (ASCE 21.2.3)	2019 CBC MCE Spectrum (7)	Site Specific Design Spectrum (8) (ASCE 21.3)	2019 CBC Design Spectrum (9) 2/3*(7)
0.00	0.743	0.730	0.732	0.732	0.732	0.730	0.730	0.637	0.487	0.425
0.05	0.988	0.971	0.797	0.797	0.797	0.797	0.797	0.898	0.531	0.599
0.10	1.234	1.212	1.110	1.110	1.110	1.110	1.110	1.159	0.740	0.772
0.15	1.451	1.425	1.386	1.386	1.386	1.386	1.386	1.419	0.924	0.946
0.20	1.668	1.639	1.587	1.587	1.587	1.587	1.587	1.593	1.058	1.062
0.30	1.899	1.907	1.797	1.797	1.797	1.797	1.797	1.593	1.198	1.062
0.40	1.869	1.876	1.822	1.822	1.822	1.822	1.822	1.593	1.215	1.062
0.50	1.840	1.927	1.746	1.746	1.746	1.746	1.746	1.593	1.164	1.062
0.75	1.540	1.611	1.419	1.419	1.419	1.419	1.419	1.593	0.946	1.062
1.00	1.241	1.434	1.200	1.200	1.200	1.200	1.200	1.460	0.800	0.973
1.50	0.951	1.100	0.859	0.859	0.859	0.859	0.859	0.973	0.573	0.649
2.00	0.662	0.795	0.656	0.656	0.656	0.656	0.656	0.730	0.438	0.487
3.00	-	-	-	-	-	-	-	-	-	-
4.00	-	-	-	-	-	-	-	-	-	-
5.00	-	-	-	-	-	-	-	-	-	-
8.00	-	-	-	-	-	-	-	-	-	-
10.00	-	-	-	-	-	-	-	-	-	-

C_{RS}:	0.893	
C_{R1}:	0.889	
Site Specific To:	0.160	$= 0.2*S_{D1}/S_{DS}$
Site Specific Ts:	0.800	$= S_{D1}/S_{DS}$

The value of Fa used in Column (3) is defined within ASCE 21.2.2 Supplement 1. This Fa value only applies within Column (3).

Probabilistic Spectrum from 2014 USGS Ground Motion Mapping Program adjusted for site conditions and maximum rotated component of ground motion using NGA, Column 2 has risk coefficients C_R applied if ASCE7-16 Section 21.2.1.1 - Method 1 is used.

Reference: ASCE 7-16, Chapters 21.2, 21.3, 21.4, 21.5, 11.4, and 11.8

Calculation Utilized ASCE7-16, Section 21.2.1.1 - Method 1

Short-Period Seismic Design Category:	**1-Second Period Seismic Design Category:**
D	D

Vertical Coefficient (C_V)
1.42

$1 g = 980.6 cm/sec^2 = 32.2 ft/sec^2$

PSV (ft/sec) = 32.2(S_a)T/(2p)

Site Coefficients	
F_{PGA}	1.10
F_a	1.00
F_v	2.50

Mapped MCE Acceleration Values		
PGA	0.689	g
S_S	1.593	g
S_1	0.584	g

Site Class	**D**
Risk Category	**III**

Site-Specific Design Acceleration Values		
PGA_M	**0.732**	**g**
S_{DS}	**1.093**	**g**
S_{D1}	**0.875**	**g**

Site-Specific MCE_R, 5% damped, Spectral Response Acceleration Parameter		
S_{MS}	**1.640**	**g**
S_{M1}	**1.313**	**g**

Key: Probab. = Probabilistic, Determ. = Deterministic, MCE = Maximum Considered Earthquake

Table 1
Fault Parameters

Fault Section Name	**Distance** (miles)	(km)	Upper Seis. Depth (km)	Lower Seis. Depth (km)	Avg Dip Angle (deg.)	Avg Dip Direction (deg.)	Avg Rake (deg.)	Trace Length (km)	Fault Type	**Mean Mag**	Mean Return Interval (years)	Slip Rate (mm/yr)
Oak Ridge (Onshore)	5.8	9.3	1.0	19.4	65	159	90	49	B	**7.2**		4
Simi-Santa Rosa	6.2	10.0	1.0	12.1	60	346	30	39	B	**6.8**		1
Malibu Coast (Extension), alt 1	6.3	10.1	0.0	7.8	74	4	30	35	B'	**6.5**		
Malibu Coast (Extension), alt 2	6.3	10.1	0.0	16.6	74	4	30	35	B'	**6.9**		
Oak Ridge (Offshore)	8.3	13.4	0.0	7.9	32	180	90	38	B	**6.9**		3
Ventura-Pitas Point	9.5	15.4	1.0	15.0	64	353	60	44	B	**6.9**		1
Channel Islands Thrust	10.2	16.4	5.0	12.3	20	354	90	59	B	**7.3**		1.5
Anacapa-Dume, alt 1	12.8	20.6	0.0	15.5	45	354	60	51	B	**7.2**		3
Anacapa-Dume, alt 2	12.8	20.6	1.2	11.4	41	352	60	65	B	**7.2**		3
Santa Cruz Island	12.8	20.7	0.0	13.3	90	188	30	69	B	**7.1**		1
Channel Islands Western Deep Ramp	14.2	22.9	4.8	12.5	21	204	90	62	B'	**7.3**		
Red Mountain	14.3	23.1	0.0	14.1	56	2	90	101	B	**7.4**		2
Malibu Coast, alt 1	16.2	26.0	0.0	7.8	75	3	30	38	B	**6.6**		0.3
Malibu Coast, alt 2	16.2	26.0	0.0	16.6	74	3	30	38	B	**6.9**		0.3
Pitas Point (Lower)-Montalvo	16.9	27.2	0.4	12.7	16	359	90	30	B	**7.3**		2.5
Sisar	17.6	28.3	0.0	17.4	29	168	na	20	B'	**7.0**		
North Channel	17.8	28.6	1.1	4.5	26	10	90	51	B	**6.7**		1
Shelf (Projection)	17.8	28.7	2.0	18.1	17	21	na	70	B'	**7.8**		
San Cayetano	19.5	31.5	0.0	16.0	42	3	90	42	B	**7.2**		6
Mission Ridge-Arroyo Parida-Santa Ana	19.8	31.8	0.0	7.6	70	176	90	69	B	**6.8**		0.4
Santa Cruz Catalina Ridge	20.9	33.6	0.0	11.0	90	38	na	137	B'	**7.3**		
Santa Monica Bay	24.8	39.9	2.3	18.0	20	44	na	17	B'	**7.0**		
Pitas Point (Upper)	25.1	40.3	1.4	10.0	42	15	90	35	B	**6.8**		1
Santa Ynez (East)	25.4	40.8	0.0	13.3	70	172	0	68	B	**7.2**		2
San Pedro Basin	26.6	42.8	0.8	12.3	88	51	na	69	B'	**7.0**		
Santa Susana, alt 1	27.5	44.2	0.0	16.3	55	9	90	27	B	**6.8**		5
Santa Susana, alt 2	27.7	44.6	0.0	10.6	53	10	90	43	B'	**6.8**		
Northridge Hills	28.9	46.6	0.0	14.9	31	19	90	25	B'	**7.0**		
Oak Ridge (Offshore), west extension	29.0	46.7	0.0	3.1	67	195	na	28	B'	**6.1**		
Pine Mtn	29.1	46.9	0.0	16.3	45	5	na	62	B'	**7.3**		
Del Valle	30.8	49.6	0.0	18.8	73	195	90	9	B'	**6.3**		
Holser, alt 1	31.2	50.3	0.0	18.6	58	187	90	20	B	**6.7**		0.4
Holser, alt 2	31.2	50.3	0.0	18.5	58	182	90	17	B'	**6.7**		
Northridge	32.3	51.9	7.4	16.8	35	201	90	33	B	**6.8**		1.5
Compton	33.6	54.1	5.2	15.6	20	34	90	65	B'	**7.5**		
San Pedro Escarpment	34.1	54.9	1.0	16.0	17	38	na	27	B'	**7.3**		
Pitas Point (Lower, West)	34.3	55.2	1.5	8.8	13	3	90	35	B	**7.2**		2.5
Santa Ynez (West)	35.0	56.3	0.0	9.2	70	182	0	63	B	**6.9**		2
Big Pine (Central)	36.7	59.0	0.0	6.6	76	167	na	23	B'	**6.3**		
Santa Monica, alt 1	36.9	59.4	0.0	17.9	75	343	30	14	B	**6.5**		1

Reference: USGS OFR 2007-1437 (CGS SP 203)

Based on Site Coordinates of 34.1573 Latitude, -119.182 Longitude

Mean Magnitude for Type A Faults based on 0.1 weight for unsegmented section, 0.9 weight for segmented model (weighted by probability of each scenario with section listed as given on Table 3 of Appendix G in OFR 2007-1437). Mean magntude is average of Ellworths-B and Hanks & Bakun moment area relationship.

APPENDIX D

Liquefaction Analysis Calculation Printouts
Liquefaction Analysis Curve Printouts
Lateral Spreading Calculation Printout

LIQUEFY-v 2.3.XLS - A SPREADSHEET FOR EMPIRICAL ANALYSIS OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE
Developed 2006 by Shelton L. Stringer, PE, GE, PG - Earth Systems Southwest

Project: **Hueneme High School Home Bleachers**
Job No: **303277-003**
Date: **2/11/2020**
Boring: **B-1** Data Set: 1

Methods: **Liquefaction Analysis using 1996 & 1998 NCEER workshop method (Youd & Idriss, editors)**
Journal of Geotechnical and Enviromental Engineering (JGEE), October 2001, Vol 127, No. 10, ASCE
Settlement Analysis from Tokimatsu and Seed (1987), JGEE,Vol 113, No.8, ASCE
Modified by Pradel, JGEE, Vol 124, No. 4, ASCE

EARTHQUAKE INFORMATION:
Magnitude: **7.2** 7.5
PGA, g: **0.76** 0.68
MSF: 1.11
GWT: **12.0** feet
Calc GWT: **6.5** feet
Remediate to: **0.0** **feet**

SPT N VALUE CORRECTIONS:
Energy Correction to N60 (C_E): 1.33 Automatic Hammer
Drive Rod Corr. (C_R): 1 Default
Rod Length above ground (feet): 3.0
Borehole Dia. Corr. (C_B): 1.00
Sampler Liner Correction for SPT?: 1 Yes
Cal Mod/ SPT Ratio: 0.63

Threshold Acceler., g: 0.11

Total (ft) Liquefied Thickness	**Total (in.) Induced Subsidence**
18.5	**4.2**

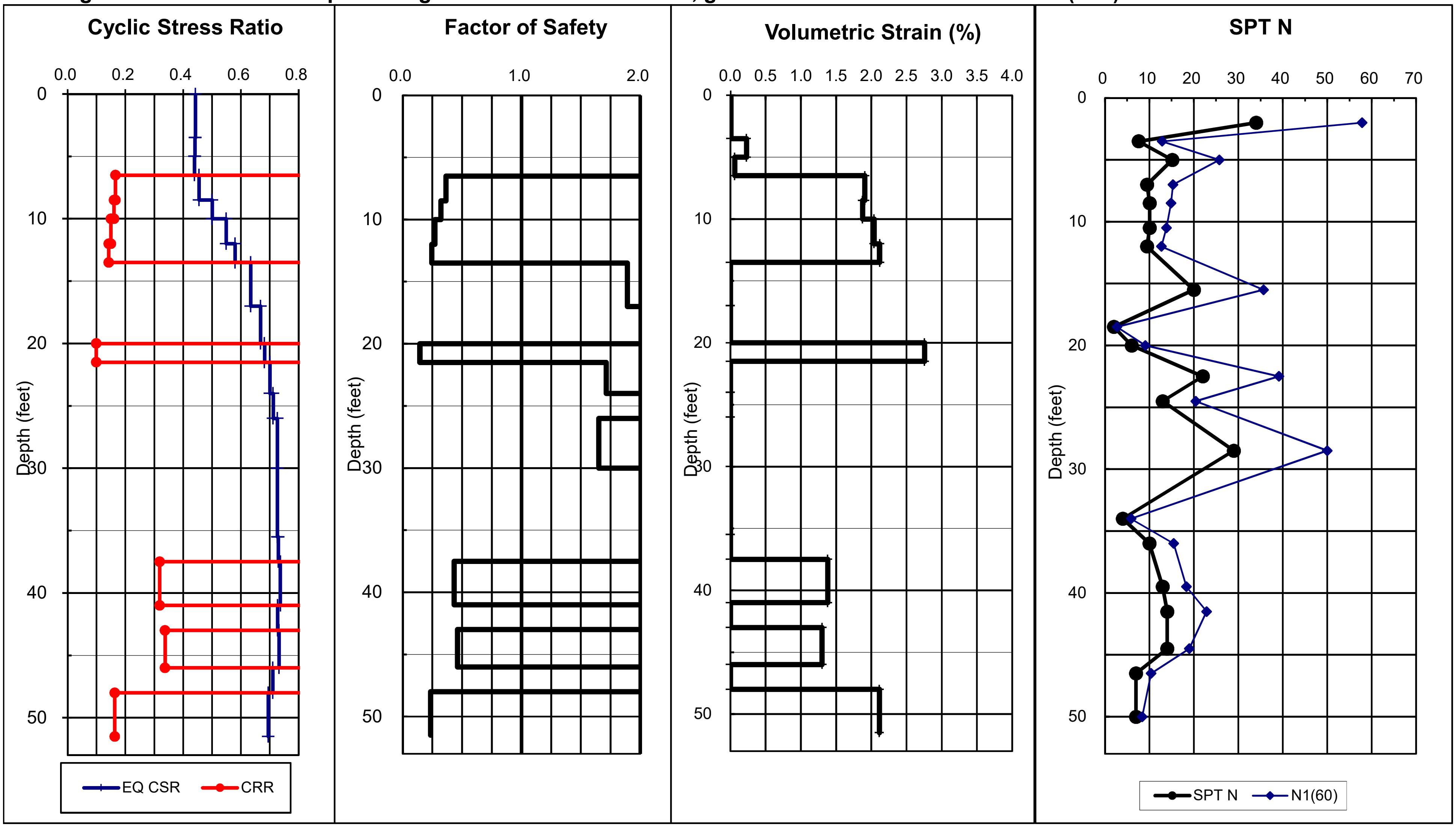
Required SF: 1.30
Minimum Calculated SF: 0.15

Base Depth (feet)	Cal Mod N	SPT N	Liquef. Suscept. (0 or 1)	Total Unit Wt. (pcf)	Fines Content (%)	Depth of SPT (feet)	Rod Length (feet)	Tot.Stress at SPT po (tsf)	Eff.Stress at SPT p'o (tsf)	rd	C_N	C_R	C_S	$N_{1(60)}$	Rel. Dens. Dr (%)	Trigger FC Adj. $\Delta N_{1(60)}$	Equiv. Sand $N_{1(60)CS}$	Kσ	M = 7.5 Available CRR	M = 7.5 Induced CSR*	**Liquefac. Safety Factor**	Post FC Adj. $\Delta N_{1(60)}$	$N_{1(60)CS}$	Volumetric Strain (%)	**Induced Subsidence (in.)**
0.0				0				0.000																	
3.5	54	**34**	1	120	52	2.0	5.0	0.120	0.120	1.00	1.70	0.75	1.00	57.8	91	10.0	67.8	1.00	1.200	0.443	**Non-Liq.**	10.0	67.8	0.01	**0.00**
5.0	12	**8**	1	110	10	3.5	6.5	0.210	0.210	0.99	1.70	0.75	1.00	12.9	43	1.1	14.0	1.00	0.152	0.441	**Non-Liq.**	1.1	14.0	0.23	**0.04**
6.5	24	15	1	110	5	5.0	8.0	0.293	0.293	0.99	1.70	0.75	1.00	25.7	61	0.0	25.7	1.00	0.295	0.440	**Non-Liq.**	0.0	25.7	0.06	**0.01**
8.5	15	9	1	110	5	7.0	10.0	0.403	0.403	0.99	1.62	0.75	1.00	15.3	47	0.0	15.3	1.00	0.166	0.455	**0.36**	0.0	15.3	1.91	**0.46**
10.0	16	10	1	110	4	8.5	11.5	0.485	0.485	0.98	1.48	0.75	1.00	14.9	46	0.0	14.9	1.00	0.161	0.501	**0.32**	0.0	14.9	1.87	**0.34**
12.0	16	10	1	110	4	10.5	13.5	0.595	0.595	0.98	1.33	0.77	1.00	13.8	44	0.0	13.8	1.00	0.150	0.549	**0.27**	0.0	13.8	2.04	**0.49**
13.5	15	9	1	110	8	12.0	15.0	0.678	0.678	0.97	1.25	0.81	1.00	12.7	43	0.5	13.2	1.00	0.142	0.580	**0.25**	0.6	13.3	2.12	**0.38**
17.0	0	20	1	110	8	15.5	18.5	0.870	0.761	0.97	1.18	0.87	1.30	35.7	71	0.7	36.4	1.00	1.200	0.634	**1.89**	0.7	36.4	0.00	**0.00**
20.0	0	2	0	110	87	18.5	21.5	1.035	0.832	0.96	1.00	0.92	1.10	2.7				1.00	Infin.	0.668	**Non-Liq.**		2.7	0.00	**0.00**
21.5	0	6	1	110	5	20.0	23.0	1.118	0.868	0.96	1.10	0.93	1.10	9.1	36	0.0	9.1	1.00	0.099	0.682	**0.15**	0.0	9.1	2.76	**0.50**
24.0	0	22	1	110	11	22.5	25.5	1.255	0.927	0.95	1.07	0.96	1.30	39.1	75	2.2	41.4	1.00	1.200	0.700	**1.71**	2.2	41.4	0.00	**0.00**
26.0	0	13	0	110	5	24.5	27.5	1.365	0.975	0.94	1.00	0.98	1.20	20.4				1.00	Infin.	0.712	**Non-Liq.**		20.4	0.00	**0.00**
30.0	0	29	1	110	14	28.5	31.5	1.585	1.070	0.93	0.99	1.00	1.30	50.0	84	4.3	54.3	1.00	1.200	0.727	**1.65**	4.3	54.3	0.00	**0.00**
35.5	0	4	0	110	77	34.0	37.0	1.888	1.201	0.90	1.00	1.00	1.10	5.9				1.01	Infin.	0.726	**Non-Liq.**		5.9	0.00	**0.00**
37.5	0	10	0	110	15	36.0	39.0	1.998	1.249	0.88	1.00	1.00	1.16	15.5				1.00	Infin.	0.730	**Non-Liq.**		15.5	0.00	**0.00**
41.0	0	13	1	110	64	39.5	42.5	2.190	1.332	0.86	0.89	1.00	1.19	18.3	51	8.7	27.0	0.97	0.319	0.737	**0.43**	4.6	22.9	1.38	**0.58**
43.0	0	14	0	110	76	41.5	44.5	2.300	1.380	0.84	1.00	1.00	1.22	22.8				0.97	Infin.	0.727	**Non-Liq.**		22.8	0.00	**0.00**
46.0		14	1	110	76	44.5	47.5	2.465	1.451	0.81	0.85	1.00	1.19	19.0	52	8.8	27.8	0.94	0.337	0.732	**0.46**	5.0	24.0	1.30	**0.47**
48.0		7	0	110	81	46.5	49.5	2.575	1.499	0.79	1.00	1.00	1.11	10.4				0.96	Infin.	0.711	**Non-Liq.**		10.4	0.00	**0.00**
51.5		7	1	110	81	50.0	53.0	2.768	1.582	0.75	0.82	1.00	1.10	8.4	35	6.7	15.1	0.94	0.163	0.695	**0.23**	5.0	13.4	2.12	**0.89**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Hueneme High School Home Bleachers **Project No: 303277-003** 1996/1998 NCEER Method

Boring: B-1 **Earthquake Magnitude: 7.2** **PGA, g: 0.76** **Calc GWT (feet): 7**



Total Thickness of Liquefiable Layers: 18.5 feet **Estimated Total Ground Subsidence: 4.2 inches**

LIQUEFY-v 2.3.XLS - A SPREADSHEET FOR EMPIRICAL ANALYSIS OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Developed 2006 by Shelton L. Stringer, PE, GE, PG - Earth Systems Southwest

Project: Hueneme High School Home Bleachers
Job No: 303277-003
Date: 2/11/2020
Boring: B-5 Data Set: 1

Methods: **Liquefaction Analysis using 1996 & 1998 NCEER workshop method (Youd & Idriss, editors)**
Journal of Geotechnical and Enviromental Engineering (JGEE), October 2001, Vol 127, No. 10, ASCE
Settlement Analysis from Tokimatsu and Seed (1987), JGEE,Vol 113, No.8, ASCE
Modified by Pradel, JGEE, Vol 124, No. 4, ASCE

EARTHQUAKE INFORMATION:

Magnitude: 7.2 7.5
PGA, g: 0.76 0.68
MSF: 1.11
GWT: 10.0 feet
Calc GWT: 6.5 feet
Remediate to: 0.0 feet

SPT N VALUE CORRECTIONS:

Energy Correction to N60 (C_E): 1.33 Automatic Hammer
Drive Rod Corr. (C_R): 1 Default
Rod Length above ground (feet): 3.0
Borehole Dia. Corr. (C_B): 1.00
Sampler Liner Correction for SPT?: 1 Yes
Cal Mod/ SPT Ratio: 0.63

Threshold Acceler., g: 0.25

Total (ft) Liquefied Thickness: 9
Total (in.) Induced Subsidence: 1.9

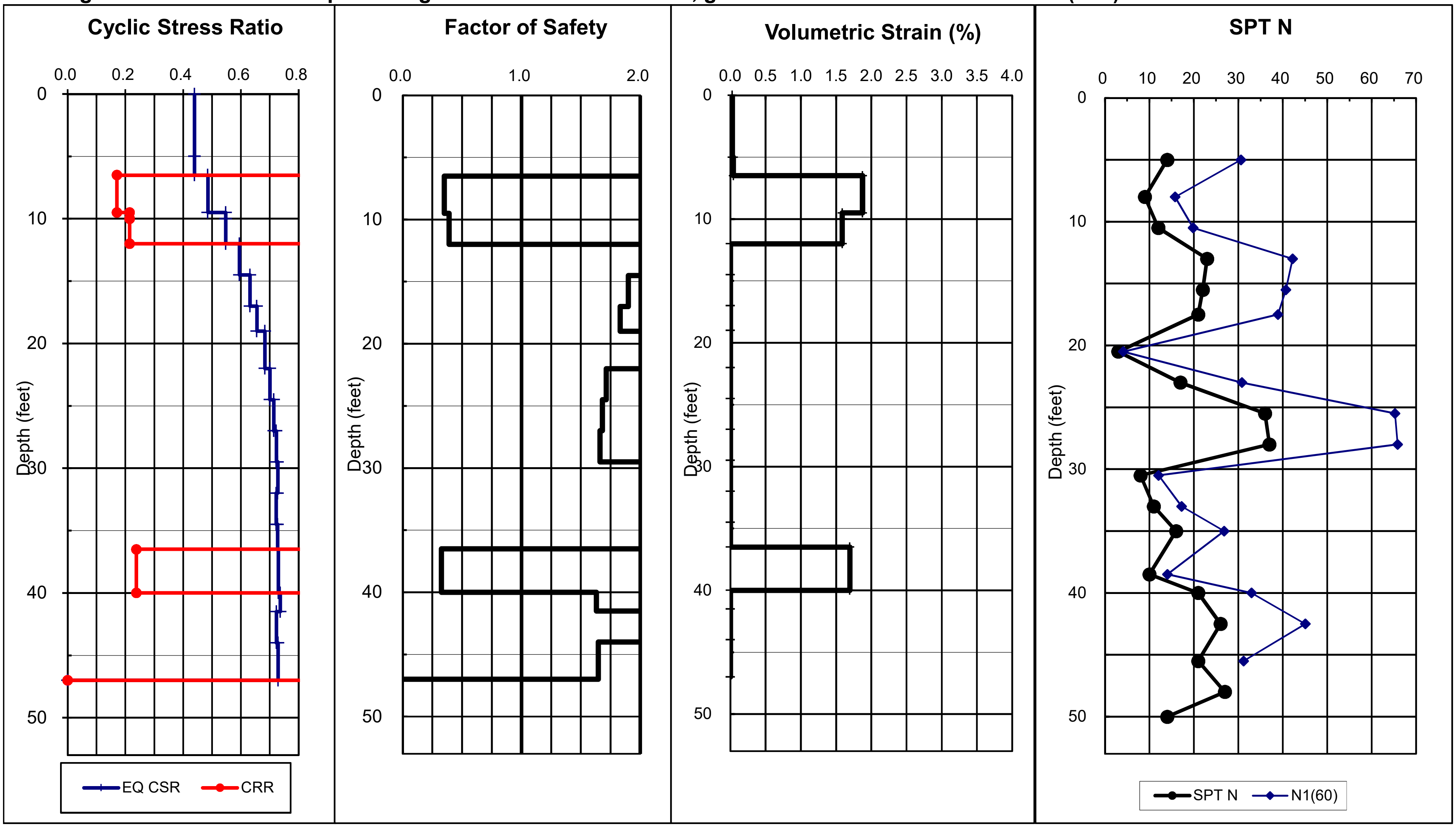
Required SF: 1.30
Minimum Calculated SF: 0.33

Base Depth (feet)	Cal Mod N	SPT N	Liquef. Suscept. (0 or 1)	Total Unit Wt. (pcf)	Fines Content (%)	Depth of SPT (feet)	Rod Length (feet)	Tot.Stress at SPT po (tsf)	Eff.Stress at SPT p'o (tsf)	rd	C_N	C_R	C_S	$N_{1(60)}$	Rel. Dens. Dr (%)	*Trigger FC Adj.* $\Delta N_{1(60)}$	*Equiv. Sand* $N_{1(60)CS}$	Kσ	M = 7.5 Available CRR	M =7.5 Induced CSR*	**Liquefac. Safety Factor**	*Post FC Adj.* $\Delta N_{1(60)}$	$N_{1(60)CS}$	Volumetric *Strain (%)*	**Induced Subsidence (in.)**
0.0				0				0.000																	
5.0	0	**14**	1	120	25	5.0	8.0	0.300	0.300	0.99	1.70	0.75	1.29	30.6	66	7.8	38.4	1.00	1.200	0.440	**Non-Liq.**	7.8	38.4	0.03	**0.02**
6.5	0	**14**	1	110	5	5.0	8.0	0.300	0.300	0.99	1.70	0.75	1.29	30.6	66	0.0	30.6	1.00	1.200	0.440	**Non-Liq.**	0.0	30.6	0.04	**0.01**
9.5	0	9	1	110	5	8.0	11.0	0.465	0.465	0.98	1.51	0.75	1.16	15.8	47	0.0	15.8	1.00	0.171	0.485	**0.35**	0.0	15.8	1.88	**0.68**
10.0	0	12	1	110	5	10.5	13.5	0.603	0.587	0.98	1.34	0.77	1.20	19.8	53	0.0	19.9	1.00	0.215	0.548	**0.39**	0.0	19.8	1.59	**0.10**
12.0	0	12	1	110	5	10.5	13.5	0.603	0.587	0.98	1.34	0.77	1.20	19.8	53	0.0	19.9	1.00	0.215	0.548	**0.39**	0.0	19.8	1.59	**0.38**
14.5	0	23	1	110	5	13.0	16.0	0.740	0.646	0.97	1.28	0.83	1.30	42.2	78	0.0	42.2	1.00	1.200	0.595	**2.02**	0.0	42.2	0.00	**0.00**
17.0	0	22	1	110	5	15.5	18.5	0.878	0.706	0.97	1.22	0.87	1.30	40.7	76	0.0	40.7	1.00	1.200	0.632	**1.90**	0.0	40.7	0.00	**0.00**
19.0	0	21	1	110	5	17.5	20.5	0.988	0.754	0.96	1.18	0.90	1.30	38.9	75	0.0	38.9	1.00	1.200	0.655	**1.83**	0.0	38.9	0.00	**0.00**
22.0	0	3	0	110	50	20.5	23.5	1.153	0.825	0.96	1.00	0.94	1.10	4.1				1.00	Infin.	0.683	**Non-Liq.**		4.1	0.00	**0.00**
24.5	0	17	1	110	25	23.0	26.0	1.290	0.884	0.95	1.09	0.97	1.29	30.8	66	7.8	38.6	1.00	1.200	0.701	**1.71**	7.8	38.6	0.00	**0.00**
27.0	0	36	1	110	5	25.5	28.5	1.428	0.944	0.94	1.06	0.99	1.30	65.3	97	0.0	65.3	1.00	1.200	0.714	**1.68**	0.0	65.3	0.00	**0.00**
29.5	0	37	1	110	5	28.0	31.0	1.565	1.003	0.93	1.03	1.00	1.30	65.9	97	0.0	65.9	1.00	1.200	0.723	**1.66**	0.0	65.9	0.00	**0.00**
32.0	0	8	0	110	75	30.5	33.5	1.703	1.063	0.92	1.00	1.00	1.13	12.0				1.00	Infin.	0.728	**Non-Liq.**		12.0	0.00	**0.00**
34.5	0	11	0	110	75	33.0	36.0	1.840	1.122	0.90	1.00	1.00	1.18	17.2				1.01	Infin.	0.722	**Non-Liq.**		17.2	0.00	**0.00**
36.5	0	16	0	110	75	35.0	38.0	1.950	1.170	0.89	1.00	1.00	1.26	26.8				1.00	Infin.	0.727	**Non-Liq.**		26.8	0.00	**0.00**
40.0	0	10	1	110	60	38.5	41.5	2.143	1.253	0.86	0.92	1.00	1.15	14.1	45	7.8	21.9	0.98	0.238	0.730	**0.33**	4.4	18.5	1.70	**0.71**
41.5	0	21	1	110	25	40.0	43.0	2.225	1.289	0.85	0.91	1.00	1.30	33.0	69	8.1	41.1	0.97	1.200	0.736	**1.63**	8.1	41.1	0.00	**0.00**
44.0	0	26	0	110	25	42.5	45.5	2.363	1.349	0.83	1.00	1.00	1.30	45.1				0.97	Infin.	0.723	**Non-Liq.**		45.1	0.00	**0.00**
47.0		21	1	110	25	45.5	48.5	2.528	1.420	0.80	0.86	1.00	1.29	31.2	67	7.9	39.1	0.94	1.200	0.729	**1.65**	7.9	39.1	0.00	**0.00**
49.5		27	0	110	60	48.0	51.0	2.665	1.479	0.77	1.00	1.00	1.30	46.8				0.95	Infin.	0.703	**Non-Liq.**		46.8	0.00	**0.00**
51.5		14	0	110	75	50.0	53.0	2.775	1.527	0.75	1.00	1.00	1.22	22.8				0.94	Infin.	0.694	**Non-Liq.**		22.8	0.00	**0.00**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Hueneme High School Home Bleachers **Project No: 303277-003** 1996/1998 NCEER Method

Boring: B-5 **Earthquake Magnitude: 7.2** **PGA, g: 0.76** **Calc GWT (feet): 7**



Total Thickness of Liquefiable Layers: 9.0 feet **Estimated Total Ground Subsidence: 1.9 inches**

Job Number:	303277-003
Job Name:	Hueneme HS Bleachers
Boring Number:	B-1
Date:	February 9, 2020
Calculated By:	A. Mazzei

Prediction of Liquefaction Induced Lateral Spreading with Ground Slope Conditions

Based on Data Published in the ASCE Journal of Geotechnicial and Geoenvironmental Engineering December 2002
(Youd, Hansen and Bartlett 2002)

Variables Used in Calculation Defined

Earthquake Magnitude (M)
Horizontal Distance to Nearest Seismic Energy Source, km (R)
Percent Slope (S)
Cumulative Thickness in Meters of Saturated Cohesionless Sediments with SPT $(N1)_{60}$ Values <= 15 (T_{15})
Average Fines Content in Percent (F_{15})
Mean Grain size in milimeters ($D50_{15}$)

$\text{Log } D_H=-16.213+1.532M-1.406\text{Log}(R+10^{(0.89M-5.64)})-0.012R+0.338\text{LogS}+0.540\text{Log}T_{15}+3.413\text{Log}(100-F_{15})-0.795\text{Log}(D50_{15}+0.1mm)$

Requirements and Limitations Used to Develop this Model

Soils must be Liquefiable
Saturated Cohesionless Sediments with SPT $(N1)_{60}$ less than 15
Earthquake Magnitude (M) must be between 6 and 8
Percent Slope (S) must be between 0.1% and 6%
Cumulative Thickness (T15) must be between 1 and 15 meters
Depth to top of Liquefied layer must be between 1 and 10 meters
Distance to Fault Rupture (R_{eq}) must be determined using Figure 10 if soft soils are present.
F_{15} and $D50_{15}$ must be within bounds shown in Fig. 5.
If R or R_{eq} < 0.5 km use 0.5; otherwise use R or R_{eq}.

Input Values	
M = 7.0	
R = 12.28	km
S = 0.3	%
T_{15} = 2.13	m
F_{15} = 52	%
$D50_{15}$ = 0.09	mm

Horizontal Ground Displacement in meters (D_H) = 0.09
Horizontal Ground Displacement in feet (D_H) = 0.31 **(3.7 inches)**

Job Number:	303277-003
Job Name:	Hueneme HS Bleachers
Boring Number:	B-5
Date:	February 9, 2020
Calculated By:	A. Mazzei

Prediction of Liquefaction Induced Lateral Spreading with Ground Slope Conditions

Based on Data Published in the ASCE Journal of Geotechnicial and Geoenvironmental Engineering December 2002
(Youd, Hansen and Bartlett 2002)

Variables Used in Calculation Defined

Earthquake Magnitude (M)
Horizontal Distance to Nearest Seismic Energy Source, km (R)
Percent Slope (S)
Cumulative Thickness in Meters of Saturated Cohesionless Sediments with SPT $(N1)_{60}$ Values <= 15 (T_{15})
Average Fines Content in Percent (F_{15})
Mean Grain size in milimeters ($D50_{15}$)

$\text{Log } D_H = -16.213 + 1.532M - 1.406\text{Log}(R + 10^{(0.89M-5.64)}) - 0.012R + 0.338\text{LogS} + 0.540\text{Log}T_{15} + 3.413\text{Log}(100 - F_{15}) - 0.795\text{Log}(D50_{15} + 0.1\text{mm})$

Requirements and Limitations Used to Develop this Model

Soils must be Liquefiable
Saturated Cohesionless Sediments with SPT $(N1)_{60}$ less than 15
Earthquake Magnitude (M) must be between 6 and 8
Percent Slope (S) must be between 0.1% and 6%
Cumulative Thickness (T15) must be between 1 and 15 meters
Depth to top of Liquefied layer must be between 1 and 10 meters
Distance to Fault Rupture (R_{eq}) must be determined using Figure 10 if soft soils are present.
F_{15} and $D50_{15}$ must be within bounds shown in Fig. 5.
If R or R_{eq} < 0.5 km use 0.5; otherwise use R or R_{eq}.

Input Values	
M = 7.0	
R = 12.28	km
S = 0.3	%
T_{15} = 1.07	m
F_{15} = 64	%
$D50_{15}$ = 0.05	mm

Horizontal Ground Displacement in meters (D_H) = 0.03
Horizontal Ground Displacement in feet (D_H) = 0.10 **(1.2 inches)**