GEOTECHNICAL ENGINEERING REPORT

FOR

PROPOSED RELOCATABLE CLASSROOM BUILDINGS

CHANNEL ISLANDS HIGH SCHOOL
1400 RAIDERS WAY
OXNARD, CALIFORNIA

PROJECT NO.: 303276-002

DECEMBER 13, 2019

PREPARED FOR

OXNARD UNION HIGH SCHOOL DISTRICT

ATTENTION: POUL HANSON

BY

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December 13, 2019

Project No.: 303275-002
Report No.: 19-12-18

Oxnard Union High School District
Attention: Poul Hanson
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Project: Proposed Relocatable Classroom Buildings
Channel Islands High School
1400 Raiders Way
Oxnard, California
Subject: Engineering Geology and Geotechnical Engineering Report

As authorized, Earth Systems Pacific (Earth Systems) has performed an engineering geology and geotechnical engineering study for proposed relocatable classroom buildings on the Channel Islands High School campus located at 1400 Raiders Way, Oxnard, California. The accompanying Engineering Geology and Geotechnical Engineering Report presents the results of our subsurface exploration and laboratory testing programs, and our conclusions and recommendations pertaining to geotechnical aspects of project design. This report completes Phase 1 of the scope of services described within our Proposal No. VEN-19-07-010 dated July 17, 2019 (Revised August 12, 2019), and authorized by Requisition No. R20-01538 dated September 3, 2019.

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,

EARTH SYSTEMS PACIFIC

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INTRODUCTION

This report presents results of an Engineering Geology and Geotechnical Engineering study performed for four (4) proposed 24-foot by 40-foot modular classrooms that will be located in the northeast corner of the Channel Islands High School located at 1400 Raiders Way in the Oxnard area of Ventura County, California (see Vicinity Map in Appendix A). The buildings will be prefabricated structures with wood foundations sitting on asphalt pavement.

The site of the proposed modular classroom buildings are currently covered with asphaltic concrete pavement. Because the sites are essentially level, grading is expected to be limited to preparing near-surface soils to support the new structures. No cut or fill slopes or retaining walls are expected to be incorporated into the grading concept.

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 of the site.
2. Reviewing geotechnical data gathered in during our previous geotechnical studies for a auto shop building on the campus.
3. Drilling, sampling, and logging five (5) exploratory borings (B-1 through B-5) to study soil and groundwater conditions.
4. Laboratory testing soil samples obtained from the subsurface exploration to determine their physical and engineering properties.
5. Consulting with owner representatives and design professionals.
6. Analyzing the geotechnical data obtained.
7. Preparing this report.

Contained in this report are:

1. Descriptions and results of field and laboratory tests that were performed for this study for a solar carport project.
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

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.

Although there are several faults located within the region, the nearest known surface fault trace of significant activity, the Simi-Santa Rosa Fault, is located approximately 4.7 miles northeast of the subject site. (For the purposes of the site-specific seismic analysis and the liquefaction evaluation, it has been assumed that the fault plane of the Oak Ridge Fault, whose surface fault trace is 5.9 miles from the site, projects downward toward the site at depth, and that the potential earthquake epicenter could be two miles from the campus.) The project area is not located within any of the “Fault Rupture Hazard Zones” that have been specified by the State of California (CDMG. 1972, Revised 1999).

The site is underlain by deltaic (alluvial) sediments consisting of loose to very dense silty and clayey sands, fine to coarse sands, and soft to firm sandy to silty clays.

The site is within one of the Liquefaction Hazard Zones designated by the California Geological Survey (CGS, 2002b).

No landslides were observed to be located on or trending into the subject property during the field study, or during reviews of the referenced geologic literature.

GEOLOGIC HAZARDS

Geologic hazards that may impact a site include seismic shaking, fault rupture, landsliding, liquefaction and flooding.

A. Seismic Shaking

Although the site is not within a State-designated "fault rupture hazard zone", it is located in an active seismic region where large numbers of earthquakes are recorded each year. Historically, major earthquakes (i.e. those with Richter magnitudes greater than 7.0) felt in the vicinity of subject site have originated from faults outside the area. These include the December 21, 1812 "Santa Barbara Region" earthquake, that was presumably centered in the Santa Barbara Channel, the 1857 Fort Tejon earthquake, the 1872 Owens Valley earthquake, and the 1952 Arvin-Tehachapi earthquake.

Southern Ventura County was mapped by the California Division of Mines and Geology in 1975 to delineate areas of varying predicted seismic response. The deltaic (alluvial) deposits that underlie the campus are mapped as having a probable maximum intensity of earthquake response of approximately IX on the Modified Mercalli Scale. Historically, the highest observed intensity of ground response has been VII in the Oxnard area (C.D.M.G., 1975).

For school projects, the 2016 California Building Code (CBC) specifies that peak ground acceleration for design purposes can be determined from a site-specific study taking 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. The program incorporates the 2008 USGS/CGS working group consensus methodologies, and the output for base ground motion is a smooth curve based on seven spectral ordinates ranging from 0 to 2 seconds. The USGS interactive deaggregation spectral values are generally within about 5% of the precise site-specific values obtained from other programs such as OpenSHA or EZ-FRISK for the same model and attenuation relationships.

The NGA (Next Generation Attenuation) relationships for spectral response have been used in the analyses. A principal advantage in the NGA relationships is that the estimated site-specific soil velocity (Vs30) is used directly for site specific analysis rather than the NEHRP site corrections. The analysis also includes amplification factors (Idriss, 1993) to model the maximum rotated component of the ground motion.

Seismic design values are referenced to the Maximum Considered Earthquake (MCE) and, by definition, the MCE has a 2% probability of occurrence in a 50-year period. This equates to a return rate of 2,475 years. Spectral acceleration parameters that are applicable to seismic design are presented in Appendix C. It should be noted that the school project carries a seismic importance factor I of 1.25 and that factor has been incorporated into the 2013 and 2016 California Building Code response spectrums.

It is assumed that the 2016 CBC and ASCE 7-10 guidelines will apply for the seismic design parameters. The 2016 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 seismic design parameters presented herein were determined by the U.S. Seismic Design Maps "risk-targeted" calculator on the USGS website for the jobsite coordinates (34.1691˚ North Latitude and -119.1632° West Longitude). The calculator adjusts for Soil Site Class E, and for Occupancy (Risk) Category III (for public school structures). (A listing of the calculated 2016 CBC and ASCE 7-10 Seismic Parameters is presented below and in Appendix C.)

Summary of Seismic Parameters – 2016 CBC

Site Class (Table 20.3-1 of ASCE 7-10 with 2016 update)	E
Occupancy (Risk) Category	III
Seismic Design Category	E
Maximum Considered Earthquake (MCE) Ground Motion	
Spectral Response Acceleration, Short Period – S_s	2.348 g
Spectral Response Acceleration at 1 sec. – S_1	0.833 g
Site Coefficient – F_a	0.90
Site Coefficient – F_v	2.40
Site-Modified Spectral Response Acceleration, Short Period – S_{MS}	2.113 g
Site-Modified Spectral Response Acceleration at 1 sec. – S_{M1}	1.999 g

Design Earthquake Ground Motion	
Short Period Spectral Response – S_{DS}	1.409 g
One Second Spectral Response – S_{D1}	1.333 g
Site Modified Peak Ground Acceleration - PGA_M	0.801 g
Note: Values Appropriate for a 2% Probability of Exceedance in 50 Years	

Because the Seismic Design Category is “E”, a site-specific seismic analysis must be performed in addition to the “general procedure”. For the purposes of the site-specific evaluation, it has been assumed that the fault plane of the Oak Ridge Fault projects downward toward the site at depth, and that the potential earthquake could happen within 2 miles of the campus. For the Site-Specific Analysis, the Short Period Spectral Response (S_{DS}) was found to be 1.127 g, and the 1 Second Spectral Response (S_{D1}) was found to be 1.204 g. Both the "site specific" and “general procedure yielded peak ground accelerations of 0.801 g.

The San Andreas is the dominant active fault in California. The fault extends from the Gulf of California to Cape Mendocino in northern California. That portion of the zone extending southward from Parkfield, California is estimated to have been active for the last 12 million years. As much as 190 miles of right lateral displacement has occurred across the zone (Crowell, 1975). This displacement includes offsets on the actual San Andreas Fault and related faults that include the Imperial, Banning, Mission Creek, and San Jacinto faults.

Historically, the San Andreas Fault is responsible for two of the three "great" earthquakes experienced in California. ("Great" earthquakes are defined as having Richter magnitudes that are equal to or greater than 8.0.) These are the 1857 Fort Tejon and 1906 San Francisco earthquakes. Each event is credited with approximately 200 miles of surface rupture and horizontal displacements of up to 30 feet. Ground shaking was very intense and damage to man-made structures very wide spread. The 1857 rupture extended along the San Andreas Fault from near Bakersfield to Cajon Pass and was felt throughout most of California. Horizontal displacements of 10 to 13 feet were observed along the fault in the Palmdale area.

Recurrence intervals for major earthquakes in southern California are best documented for the San Andreas Fault. It is estimated that a major earthquake has occurred along the southern portion of the San Andreas Fault every 100 to 200 years (Sieh, 1978). The average recurrence interval is estimated to be 140 years. The last major earthquake on the San Andreas Fault in the southern California area occurred in 1857; therefore, the occurrence of a major event in the same general area is considered likely within the estimated lifetime of any new construction.

On December 21, 1812, an estimated 7.0 Richter magnitude event occurred in an area believed to be offshore in the western part of the Santa Barbara Channel. This earthquake caused considerable shaking in the area of the proposed project.

On March 26, 1872, the greatest recorded earthquake in the western United States, excluding Alaska, occurred along the Owens Valley Fault near Lone Pine. The earthquake is estimated to have had a Richter magnitude of 8.25, and significantly shook most of California.

On July 21, 1952, the Arvin-Tehachapi earthquake occurred on the White Wolf Fault. The earthquake registered 7.7 on the Richter Scale and was felt throughout southern California.

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 in any of the referenced documents, including the Ventura County General Plan. 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

The subject site and surrounding areas are essentially level. Thus, potential hazards due to landsliding and rock fall are nil.

D. Liquefaction, Lateral Spreading, and Seismic-Induced Settlement of Dry Sands

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 in each of the borings drilled for this study. Groundwater was encountered in the borings at depths ranging from approximately 10 to 11 feet below the existing ground surface. However, mapping of historically high groundwater levels by the California Geological Survey (CGS, 2002a) indicates that groundwater has been 5 below the ground surface near the subject site.
2. The soil profile consists of interbedded, discontinuous strata of non-plastic sands, silts and clays.
3. 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 7.4 moment magnitude event, and a site modified peak ground acceleration of 0.801 g was assumed, as per the discussion in the "Seismicity and Seismic Design" section of this report. Soil stratigraphic and engineering data interpreted from Boring B-2 were utilized. Groundwater was assumed to be at the historically high groundwater depth of 5 feet below the existing ground surface.

The analysis with the groundwater level at the historically high groundwater depth of 5 feet indicated that potentially liquefiable layers totaling about 10 feet in thickness had factors of safety that were less than 1.3, with the shallowest layer between the depths of 5 and 11 feet (see Appendix D for calculations) below the ground surface. Those zones below the groundwater table 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 total volumetric strain was found to be approximately 4.2 inches. Of the total ground subsidence estimated, approximately 3.5 inches of this is liquefaction-induced, while the remaining 0.7 inches is from seismically-induced settlement of dry sands.

According to a chart derived by Ishihara (National Academy Press, 1985), "ground" damage would be expected related to the potentially liquefiable zones identified in the Boring B-2 because of the 5-foot thickness of non-liquefiable soils above the 6-foot thick shallowest potentially liquefiable layer. The construction of a geogrid-reinforced mat beneath the proposed relocatable classroom buildings will mitigate the potential for ground damage at the site. (Examples of ground damage are sand boils and ground cracks.).

Although the construction of a geogrid-reinforced mat beneath the proposed relocatable classroom buildings 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 settlement of dry sands could potentially range up to about 4.2 inches without any remedial grading being performed. The construction of a geogrid-reinforced mat beneath the proposed relocatable classroom buildings will reduce the estimated total seismically-induced settlement to 3.5 inches. According to SCEC (1999), up to about half of the total settlement could be realized as differential settlement. However, the geogrid-reinforced mat beneath the proposed relocatable classroom buildings will provide more uniform settlement to occur. As a result, differential settlement beneath the proposed relocatable classroom buildings could range up to about 1.2 inches at the ground surface.

”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 the potentially liquefiable zones between the depths 5 and 11 feet and 33 to 37 feet below the ground surface. The cumulative thickness of this layer is about 3 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 0.2%, which is approximately equivalent to 5 feet in 2,000 feet, as shown on the Oxnard Quadrangle. Fine contents were assumed to be 30% based on the soil types within these zones. The cumulative displacement was calculated to be about 1.7 feet, if both of these potentially liquefiable zones were to liquefy. (Calculations are included within Appendix D of this report.)

Based on the above, it is the opinion of this firm that a potential for liquefaction and lateral spreading exists at the proposed bathroom site.

E. Flooding

Earthquake-induced flooding types include tsunamis, seiches, and reservoir failure. Due to the inland location of the site, hazards from tsunamis and seiches are considered extremely unlikely.

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 located within an area designated by FEMA Flood Map Service Center website as Zone X, which is designated as an “area of minimal flood hazard". As a result, it appears that the hazard posed by storm-induced flooding is low.

SOIL CONDITIONS

Based on the exploratory borings drilled for this study, artificial fill soils were encountered to depths ranging from approximately 3.5 to 5 feet below the existing ground surface. The artificial fill is underlain by native alluvial soils to the maximum depth explored of 51.5 feet. The alluvial soils consisted of interbedded, discontinuous strata of sands, silty sands, clayey silts, sandy silts, and silty clays.

Testing indicates that anticipated bearing soils lie in the "very low" expansion range of Table 1809.7 because the expansion index was found to be 0. [A locally adopted version of this classification of soil expansion is included in Appendix B of this report.] It appears that soils can be cut by normal grading and/or drilling equipment.

Groundwater was encountered in each of the borings drilled for this study. Groundwater was encountered in the borings at depths ranging from approximately 10 to 11 feet below the existing ground surface. Mapping of historically high groundwater levels by the California Geological Survey (CGS, 2002a) indicates that groundwater has been 5 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 (230 mg/Kg) are in the “S0” (“negligible”) exposure class of Table 19.3.1.1 of ACI 318-14; therefore, it appears that special concrete designs will not be necessary for the measured sulfate contents.

Based on criteria established by the County of Los Angeles (2013), measurements of resistivity of near-surface soils (3,000 ohms-cm) indicate that they are “moderately corrosive” to ferrous metal (i.e. cast iron, etc.) pipes.

GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

As noted above, there is a potential for liquefaction to produce differential settlements in the proposed building areas. Without mitigation, the currently proposed wood foundations may not be structurally capable of withstanding anticipated differential settlements of approximately 1.2 inches. The following remedial recommendations are intended to reduce potential differential settlement to a level where the proposed modular classroom buildings could be supported by wood foundations on asphalt pavement.

To mitigate the anticipated liquefaction-related effects, Earth Systems recommends that a geogrid reinforced mat be constructed beneath the relocatable buildings. The intent of the geogrid reinforced mat is to stiffen underlying soils so that they act as a rigid mass that would act as a unit during horizontal displacements from lateral spreading, result in more uniform settlement beneath the structures to reduce differential settlement, and prevent a bearing capacity failure.

To create the geogrid reinforced mats, native soils beneath the proposed buildings should be excavated a minimum of 5 feet below existing grade, or as deep to remove all fill soils, whichever is deeper. The limits of overexcavation should be extended laterally to a distance of at least 5 feet beyond the outside edges of the foundation element wherever no existing structures are located within 10 feet of the outside edge of the overexcavation zone. If existing structures are within 10 feet of the lateral overexcavation limit, the overexcavation width may be reduced to 3 feet outside the building perimeter in that direction only. The bases of the overexcavation zones should be relatively level.

The bottoms of the remedial excavations should be scarified to a depth of 6 inches, uniformly moisture conditioned to above optimum moisture content; and compacted to achieve a relative compaction of at least 90 percent of the ASTM D 1557 maximum dry density. Following compaction of the bottom, a layer of geogrid should be placed on the prepared subgrade that extends across the entire area of overexcavation and up the sidewalls of the remedial excavation. The reinforcing geogrids should consist of Tensar Tri-Axial TX7, or equivalent as approved by the Geotechnical Engineer. Where more than one geogrid roll is required, the rolls should be overlapped at least 3 feet. A 1-foot layer of one-inch minus aggregate base material should be placed and compacted over the bottom layer of geogrid. The aggregate base material should be uniformly moisture conditioned to at or above optimum moisture content and compacted to achieve a relative compaction of at least 95 percent of the ASTM D 1557 maximum dry density. A second layer of geogrid should be placed over the compacted aggregate base material, and an additional foot of aggregate base material should be placed and compacted on top of the second geogrid layer. The second layer of geogrid rolls should be overlapped by 3 feet where necessary, and extend across the entire excavation; however, it does not need to extend up the sidewalls. Once the second lift of aggregate base material has been placed and compacted, the remedial excavation may then be brought up to finished subgrade elevation using the excavated soil compacted to at least 95 percent of the ASTM D 1557 maximum dry density. Once the fill reaches 6 inches below finished subgrade elevation, the bottom layer of geogrid extending up the sidewall of the remedial excavation should be pulled down onto the compacted surface to create an 8-foot overlap. The remedial excavation may then be brought up to finished subgrade using the excavated soil compacted to at least 95 percent of the ASTM D 1557 maximum dry density. The area may then be paved to match the existing structural paving section.

The modular building manufacturer and installer may choose to increase the number of pipe anchors used to firmly secure the building into the geogrid reinforced mat and stiffen the wood foundation.

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 on the site during earlier site studies. 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 structure(s) and other 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.

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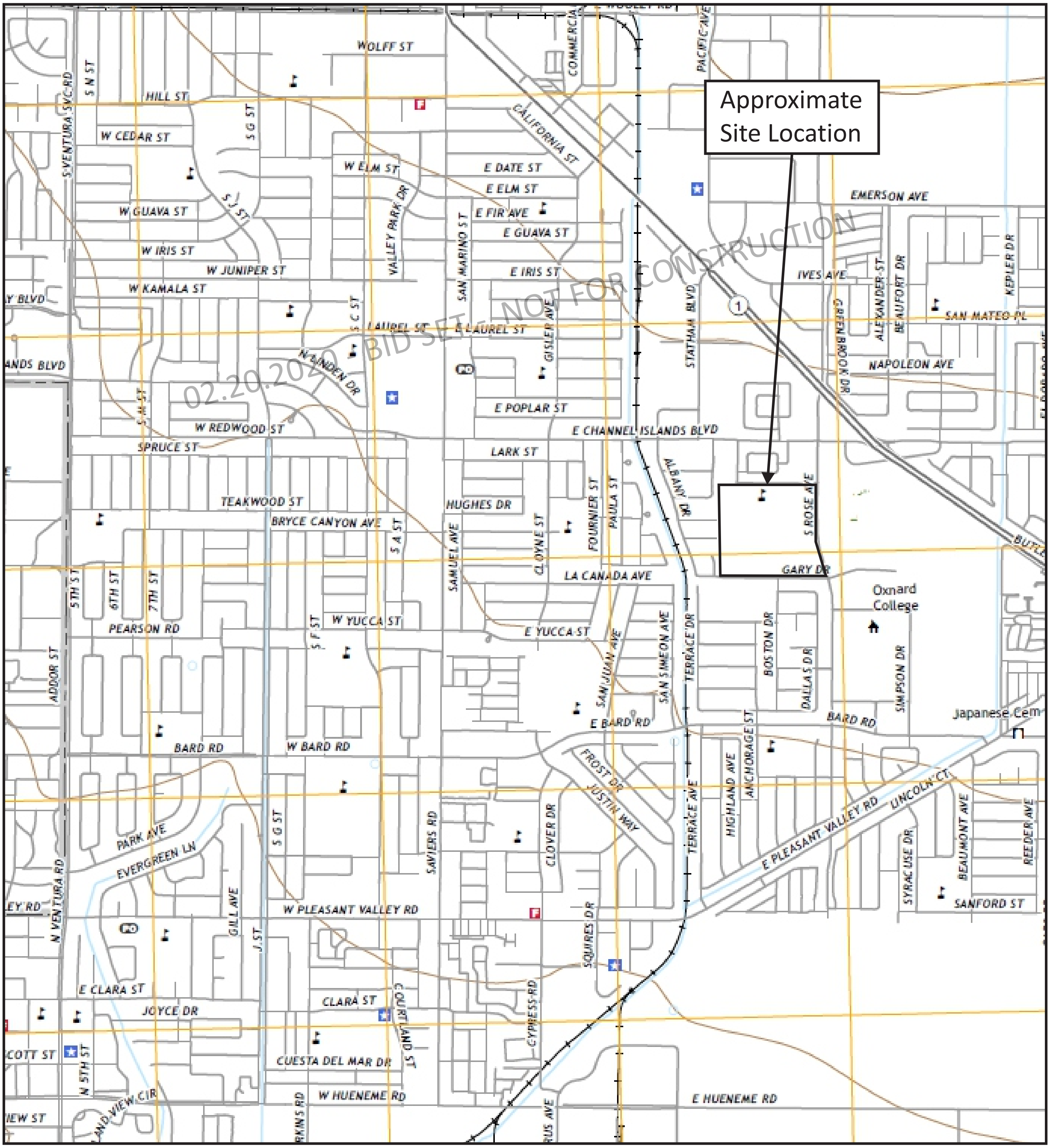
APPENDIX A



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

Approximate Scale: 1" = 2,000’

0 2,000’ 4,000’

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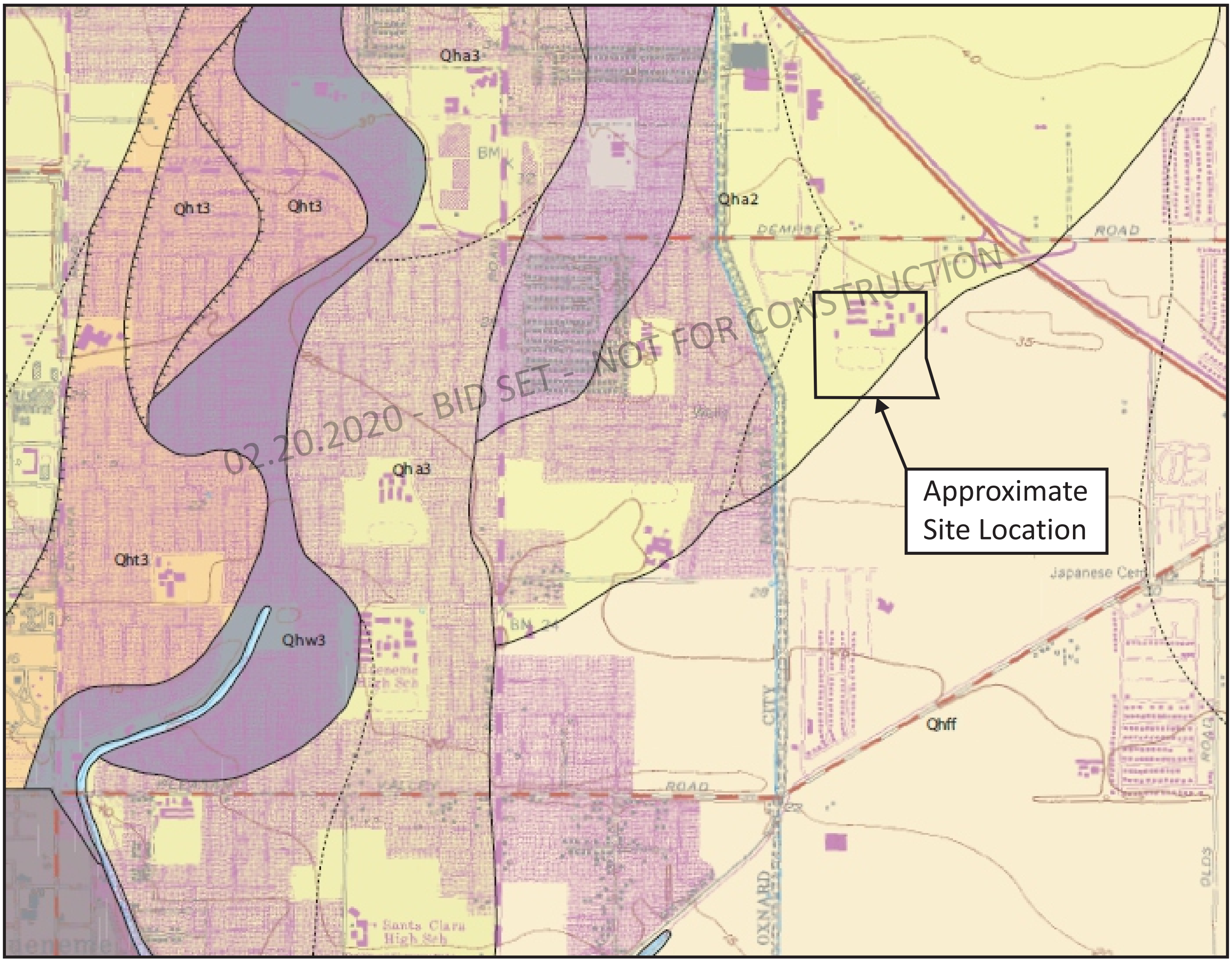
VICINITY MAP

Channel Islands High School
Proposed Relocatable Classroom Buildings
Oxnard, California

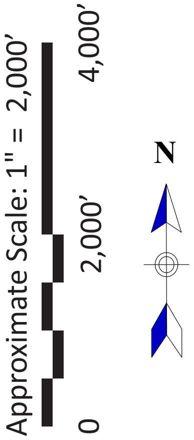
Earth Systems

December 2019	303276-002



Approximate Site Location

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



Southern California USGS SCAMP CDMG Areal Mapping Project

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.

Qha2: Holocene alluvial deposits

Qhff: Holocene alluvial fan deposits

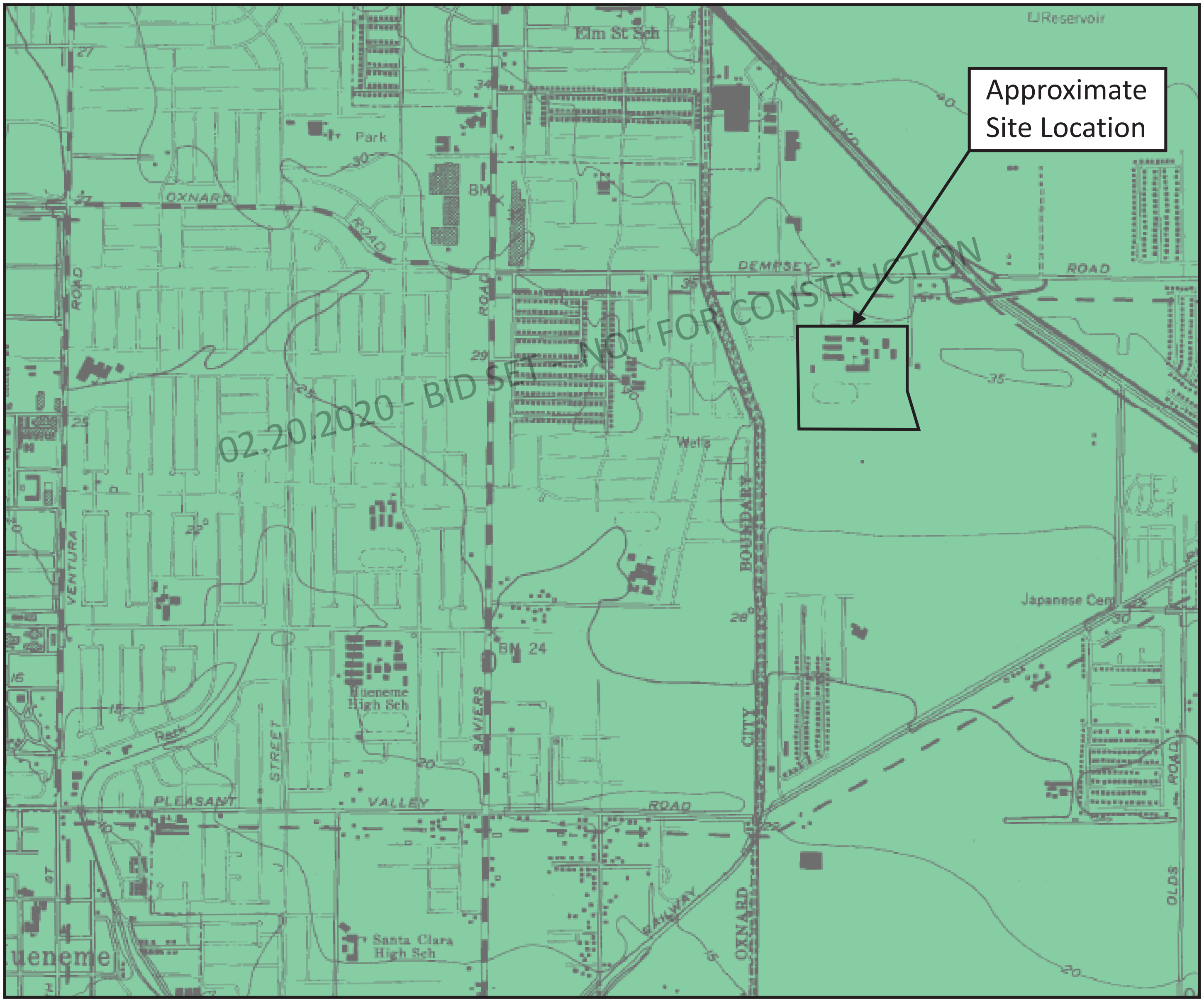
REGIONAL GEOLOGIC MAP

Channel Islands High School
Proposed Relocatable Classroom Buildings
Oxnard, California

Earth Systems

December 2019

303276-002



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’

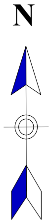
0 2,000’ 4,000’

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

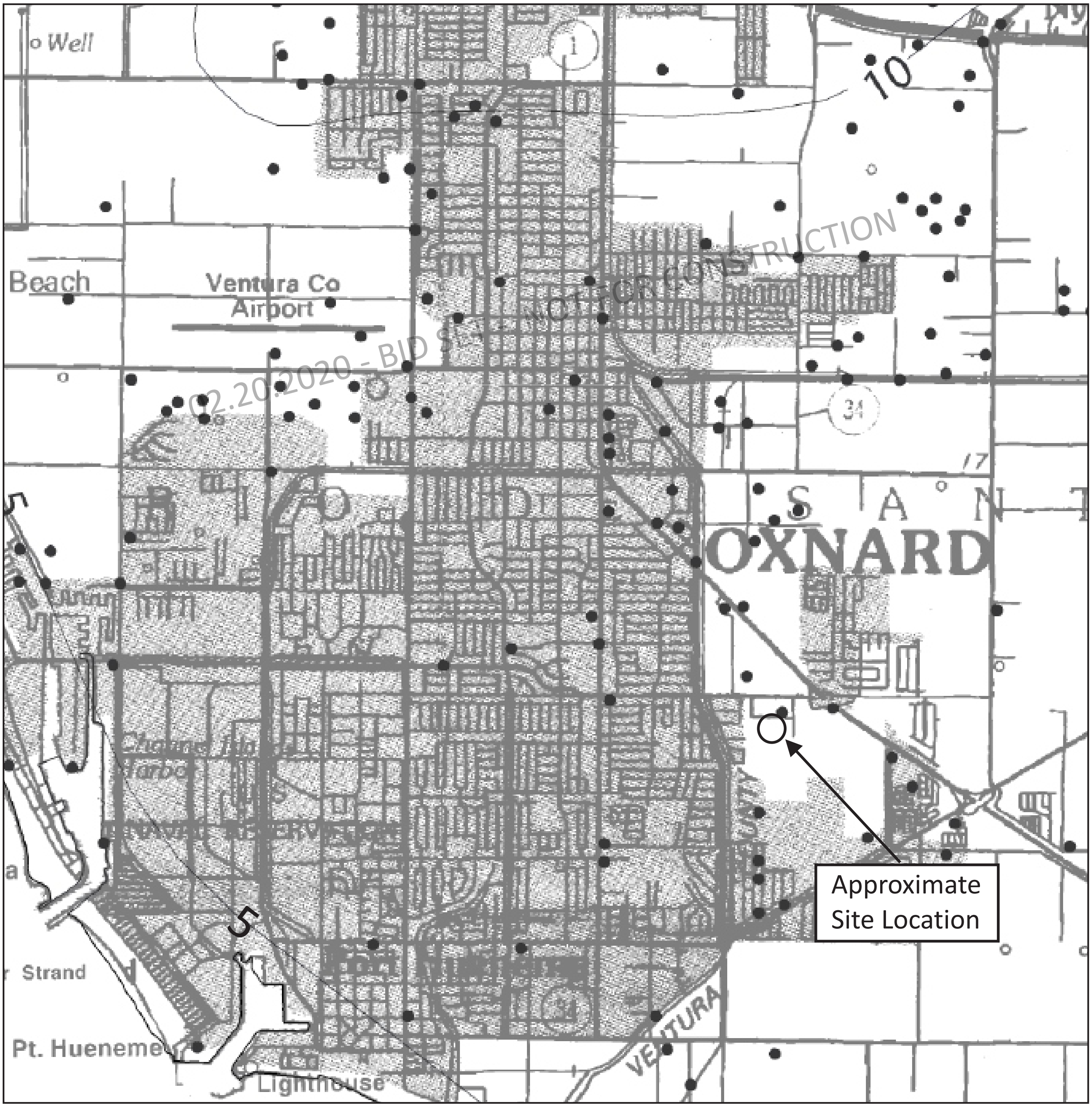


SEISMIC HAZARD ZONES MAP

Channel Islands High School
Proposed Relocatable Classroom Buildings
Oxnard, California

Earth Systems

December 2019 | 303276-002



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

30 Depth to ground water in feet

● Borehole Site

Approximate Scale: 1" = 4,000'

0 4,000' 8,000'

N

HISTORICAL HIGH GROUNDWATER MAP

Channel Islands High School
Proposed Relocatable Classroom Buildings
Oxnard, California

Earth Systems

December 2019 303276-002

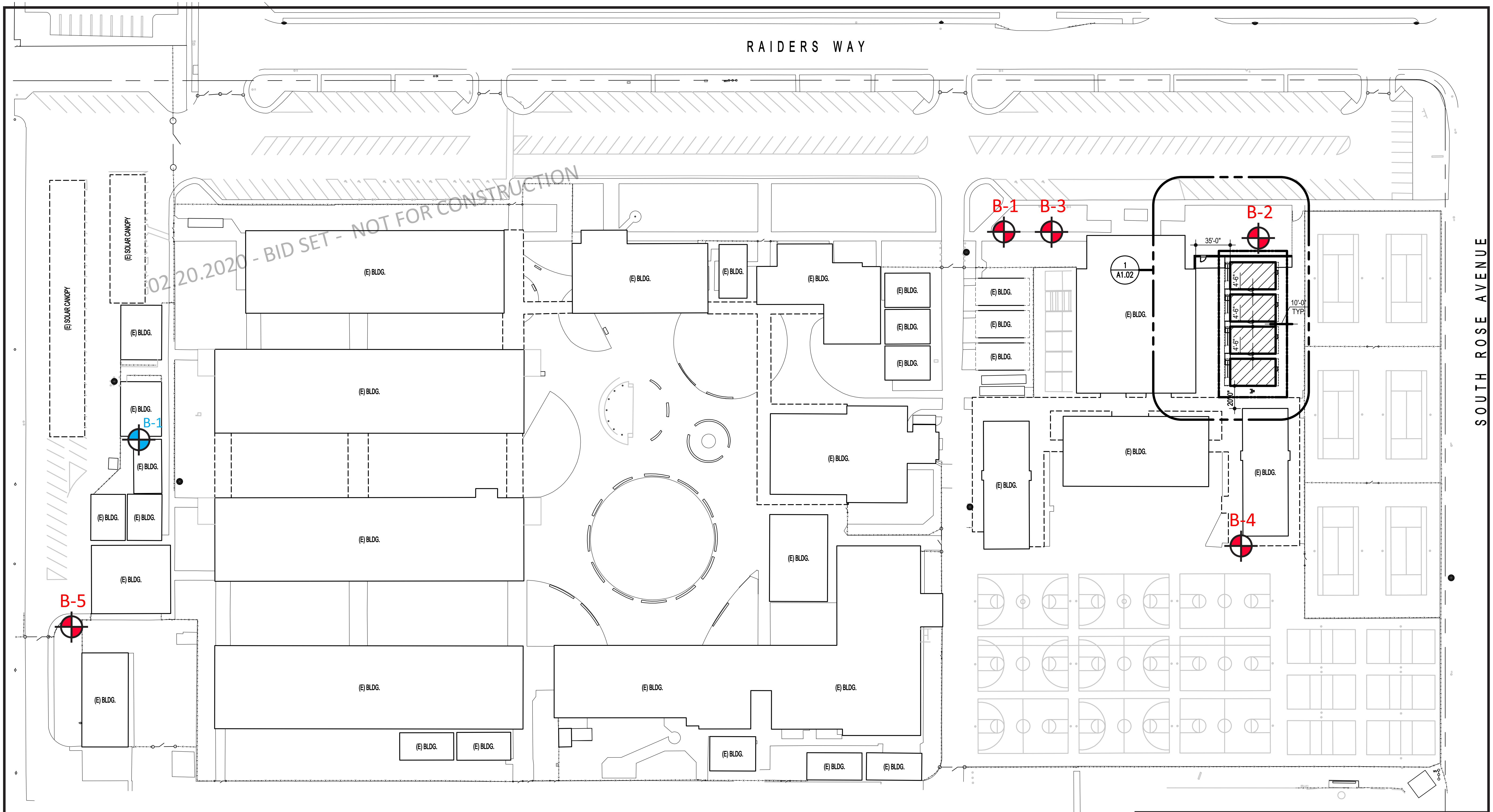
FIELD STUDY

A. Five borings (B-1 through B-5) were drilled to depths ranging from approximately 11.5 to 51.5 feet below the existing ground surface to observe the soil profile and to obtain samples for laboratory analyses. Two borings were drilled on October 21, 2019, using mud rotary drilling methods. The remaining three borings were drilled on October 23, 2019, using 8-inch diameter hollow-stem continuous flight auger powered by a Simco 2800 truck mounted drilling rig. The approximate locations of the borings were determined in the field by pacing and sighting, and are shown on the Site Plan in this Appendix.

B. Samples were obtained within the 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 by driving the samplers with a 140-pound hammer dropping 30 inches in accordance with ASTM D 1586. The hammer was operated with an automatic trip mechanism.

C. One bulk sample was collected from the cuttings of the soils encountered in Boring B-1 between the depths of 0 and 5 feet.

D. 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 for the borings drilled for this study are included in this Appendix.



B-5

🟥 : Approximate boring locations.

B-1

🟦 : Approximate boring locations from 2010.

Approximate Scale: 1" = 100’

0 100’ 200’

N

SITE PLAN

Channel Islands High School
Proposed Relocatable Classroom Buildings
Oxnard, California

Earth Systems

December 2019	303276-002

Logs of Borings

Earth Systems

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

BORING NO: B-1
PROJECT NAME: Channel Islands H.S. Relocatables
PROJECT NUMBER: 303276-002
BORING LOCATION: Per Plan

DRILLING DATE: October 23, 2019
DRILL RIG: Simco 2800
DRILLING METHOD: 8.0-Inch Hollow Stem Auger
LOGGED BY: SC

Vertical Depth	Sample Type			PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
	Bulk	SPT	Mod. Calif.						
0	☒		■	6/9/12		ML	98.3	13.2	**ARTIFICIAL FILL:** Mottled brown sandy silt; medium dense; damp to moist.
5			■	4/4/8		ML /SM	84.7	32.1	**ALLUVIUM:** Mottled yellowish brown sandy silt and silty fine sand; loose; moist.
▼			■	4/6/6		ML /SM	93.2	28.7	**ALLUVIUM:** Mottled yellowish brown sandy clayey silt; some caliche; medium stiff; moist.
10			■	7/14/24		SM	100.9	21.3	**ALLUVIUM:** Gray slightly silty fine sand; medium dense; wet.
15		■		3/13/19		SM			**ALLUVIUM:** Gray slightly silty fine sand with silt interbeds; dense; wet.
20									Total Depth: 16.5 feet. Groundwater Depth: 10.0 feet.
25									
30									
35									

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

BORING NO: B-2	DRILLING DATE: October 21, 2019
PROJECT NAME: Channel Islands H.S. Relocatables	DRILL RIG: Gtech 8
PROJECT NUMBER: 303276-002	DRILLING METHOD: Mud Rotary
BORING LOCATION: Per Plan	LOGGED BY: AL

Vertical Depth	Sample Type Bulk	SPT	Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6"	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0									
5									
		■		3/1/1	SM				**ALLUVIUM:** Gray Brown Silty fine Sand, trace medium to coarse Sand, very loose-damp to moist
10 ▼		■		6/9/11	SM				**ALLUVIUM:** Dark Gray Silty fine to medium Sand, trace coarse Sand, medium dense-very moist
		■		7/8/6					
15		■		3/4/11	SC				**ALLUVIUM:** Dark Gray Clayey fine to medium Sand, medium dense-very moist
		■		9/9/6	SM				**ALLUVIUM:** Gray Silty fine to medium Sand, trace fine Gravel, medium dense-very moist to wet
20		■		12/16/20	SM				**ALLUVIUM:** Gray Silty fine to medium Sand, little coarse Sand, trace fine Gravel, dense-very moist to wet
		■		11/13/17					
25		■		10/12/11	SW				**ALLUVIUM:** Gray fine to coarse Sand, little Silt, trace fine Gravel, medium dense-wet
		■		6/12/22	CL				**ALLUVIUM:** Dark Gray Silty Clay, little fine to coarse Sand, trace fine Gravel, hard-wet
30		■		8/13/18	ML				**ALLUVIUM:** Light Gray Brown Silty fine Sand to fine Sandy Silt, hard-moist
35		■		8/5/4	ML		--	30.1	**ALLUVIUM:** Gray Brown fine Sandy Silt, little Clay, stiff-moist
		■		12/13/21	SM				**ALLUVIUM:** Light Gray Silty fine Sand to fine Sandy Silt, dense-damp

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

BORING NO: B-2 (Continued)
PROJECT NAME: Channel Islands H.S. Relocatables
PROJECT NUMBER: 303277-002
BORING LOCATION: Per Plan

DRILLING DATE: October 21, 2019
DRILL RIG: Gtech 8
DRILLING METHOD: Mud Rotary
LOGGED BY: AL

Vertical Depth	Sample Type			PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
	Bulk	SPT	Mod. Calif.						
40		■		10/20/26	SM	▥			**ALLUVIUM:** Gray Silty fine Sand, dense-damp to moist
		■		10/25/26	SP	░			**ALLUVIUM:** Gray fine to medium Sand, little Silt, very dense-moist
45									
		■		10/17/27	SP	░			**ALLUVIUM:** Gray fine to medium Sand, little Silt, dense-moist
50		■		5/10/16	ML	▥			**ALLUVIUM:** Gray Clayey Silt, very stiff-damp to moist
									Total Depth: 51.5 feet. **Groundwater Depth: 11.0 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.

Earth Systems

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BORING NO: B-3	DRILLING DATE: October 23, 2019
PROJECT NAME: Channel Islands H.S. Relocatables	DRILL RIG: Simco 2800
PROJECT NUMBER: 303276-002	DRILLING METHOD: 8.0-Inch Hollow Stem Auger
BORING LOCATION: Per Plan	LOGGED BY: SC

Vertical Depth	Sample Type			PENETRATION RESISTANCE (BLOWS/6"	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
	Bulk	SPT	Mod. Calif.						
0					▥	ML			**ARTIFICIAL FILL:** Mottled brown sandy silt; medium dense; damp to moist.
5			■	4/6/8	▥	ML			**ALLUVIUM:** Mottled yellowish brown sandy silt; stiff; moist.
			■	5/6/7	▥	ML			**ALLUVIUM:** Mottled yellowish brown sandy silt; some caliche; stiff; moist.
▼ 10			■	8/10/15	⁙	SM			**ALLUVIUM:** Gray slightly silty fine sand; medium dense; wet.
15									Total Depth: 11.5 feet. Groundwater Depth: 10.0 feet.
20									
25									
30									
35									

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
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BORING NO: B-4	DRILLING DATE: October 23, 2019
PROJECT NAME: Channel Islands H.S. Relocatables	DRILL RIG: Simco 2800
PROJECT NUMBER: 303276-002	DRILLING METHOD: 8.0-Inch Hollow Stem Auger
BORING LOCATION: Per Plan	LOGGED BY: SC

Vertical Depth	Sample Type Bulk	SPT	Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0									3.5" Asphalt; 5.0" Base Material.
			■	7/10/15	▥	ML			**ARTIFICIAL FILL:** Mottled brown sandy silt; very stiff; damp to moist.
			■		░				**ALLUVIUM:** Yellowish brown fine silty sand; medium dense; moist.
5			■	5/12/23	░	SP			**ALLUVIUM:** Pale yellowish brown silty fine sand; medium dense; damp.
			■	12/19/24	░	SP			Same as above.
10 ▼			■	12/14/18	░	SP			**ALLUVIUM:** Dark yellowish brown silty sand; fine to medium grain; medium dense; wet.
15		■		8/10/14	▦	SM			**ALLUVIUM:** Gray silty fine sand; some coarse gravel; medium dense; wet.
20									Total Depth: 16.5 feet. Groundwater Depth: 10.5 feet.
25									
30									
35									

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	DRILLING DATE: October 21, 2019
PROJECT NAME: Channel Islands H.S. Relocatables	DRILL RIG: Gtech 8
PROJECT NUMBER: 303276-002	DRILLING METHOD: Mud Rotary
BORING LOCATION: Per Plan	LOGGED BY: AL

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									
5									
		■		10/10/11	SP				**ALLUVIUM:** Gray fine to medium Sand, little silt, medium dense-very moist to wet
10 ▼		■		7/8/9					
		■		8/10/11	SM				**ALLUVIUM:** Dark Gray silty fine Sand, medium dense-very moist to wet
15		■		7/8/12	SP				**ALLUVIUM:** Dark Gray fine to medium Sand, medium dense-wet
		■		9/7/9	SM				**ALLUVIUM:** Dark Gray Silty fine to medium Sand, trace Clay nodules, medium dense, wet
20		■		12/12/16	SP				**ALLUVIUM:** Gray fine to medium Sand, little Silt, trace fine Gravel, medium dense to dense, wet
		■		12/14/18					
25		■		13/12/6					
		■		5/4/4	ML				**ALLUVIUM:** Gray Brown fine Sandy Silt, medium stiff, damp to moist
30		■		8/11/10	ML				**ALLUVIUM:** Gray fine Sandy Silt to Silty fine Sand, very stiff, moist
		■		3/4/6	CL		--	25.7	**ALLUVIUM:** Dark Gray fine Sandy Clay, stiff, very moist
35		■		6/8/11	ML				**ALLUVIUM:** Gray fine Sandy Silt, trace to little Clay, very stiff, moist
		■		6/10/17					

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: October 21, 2019
PROJECT NAME: Channel Islands H.S. Relocatables	DRILL RIG: Gtech 8
PROJECT NUMBER: 303277-002	DRILLING METHOD: Mud Rotary
BORING LOCATION: Per Plan	LOGGED BY: AL

Vertical Depth	Sample Type Bulk	 SPT	 Mod. Calif.	PENETRATION RESISTANCE (BLOWS/6")	SYMBOL	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
40				14/14/16	SM				**ALLUVIUM:** Gray Silty fine Sand, little medium Sand, medium dense to dense, very moist
				12/6/5	ML		--	35.3	**ALLUVIUM:** Dark Gray Clayey Silt, stiff, very moist
45				8/11/7	SM				**ALLUVIUM:** Gray Silty fine Sand to fine Silty Sand, little Clay, medium dense, moist
				3/4/8	ML /CL		--	30.7	**ALLUVIUM:** Dark Gray Silty Clay, medium stiff to stiff, very moist
50				1/2/4					
									Total Depth: 51.5 feet. **Groundwater Depth: 11.0 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.

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 LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED 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 PASSING 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 SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS 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 GREATER 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 with Footnotes

LABORATORY TESTING

A. Samples were reviewed along with field logs to determine which would be analyzed further. Those chosen for laboratory analyses 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 dry unit weight for the ring samples were determined in general accordance with ASTM D 2937.

C. A maximum density test was performed to estimate the moisture-density relationship of typical soil materials. The test was performed in accordance with ASTM D 1557.

D. The relative strength characteristics of soils were determined from the results of a direct shear test on a remolded sample. The specimen was placed in contact with water at least 24 hours before testing, and was then sheared under normal loads ranging from 1 to 3 ksf in general accordance with ASTM D 3080.

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

G. The gradation characteristics of certain samples were evaluated by hydrometer (in accordance with ASTM D 7928) and sieve analysis procedures. The 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 particles that passed the No. 200 screen. The hydrometer portions of the tests were run using sodium hexametaphosphate as a dispersing agent.

I. A portion of the bulk sample 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.

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

TABULATED LABORATORY TEST RESULTS

REMOLDED SAMPLE

BORING AND DEPTH	B-1 @ 0'-5'
USCS	ML
MAXIMUM DRY DENSITY (pcf)	116.0
OPTIMUM MOISTURE (%)	12.0
PEAK COHESION (psf)	140.0
PEAK FRICTION ANGLE	24°
ULTIMATE COHESION (psf)	40
ULTIMATE FRICTION ANGLE	26°
EXPANSION INDEX	0
pH	8.2
RESISTIVITY (ohms-cm)	3,000
SOLUBLE CHLORIDES (mg/Kg)	49
SOLUBLE SULFATES (mg/Kg)	230

BORING AND DEPTH	B-2 @ 15’	B-2 @ 35’	B-5 @ 22.5’
USCS	SC	ML	SP
LIQUID LIMIT	--	29	--
PLASTIC LIMIT	--	27	--
PLASTICITY INDEX	--	2	--
PERCENT PASSING No. 200 SIEVE (%)	37	86	5

BORING AND DEPTH	B-5 @ 27.5’	B-5 @ 32.5’	B-5 @ 42.5’
USCS	ML	CL	ML
LIQUID LIMIT	--	31	39
PLASTIC LIMIT	--	22	30
PLASTICITY INDEX	--	9	9
PERCENT PASSING No. 200 SIEVE (%)	51	76	5

Individual Laboratory Test Results

UNIT DENSITIES AND MOISTURE CONTENT

ASTM D2937 & D2216

Job Name: Channel Islands H.S. Relocatables

Sample Location	Depth (feet)	Unit Dry Density (pcf)	Moisture Content (%)	USCS Group Symbol
B-1	2.5	98.3	13.2	ML
B-1	5	84.7	32.1	ML
B-1	7.5	93.2	28.7	ML/SM
B-1	10	100.9	21.3	SM
B-2	35	---	30.1	ML
B-3	5	85.0	17.5	ML
B-3	7.5	95.1	29.3	ML
B-3	10	102.7	18.1	SM
B-4	2.5	105.7	22.8	ML
B-4	5	108.4	4.0	SP
B-4	7.5	107.0	4.4	SP
B-4	10	92.6	15.1	SP
B-5	32.5	---	25.7	CL
B-5	42.5	---	35.3	ML
B-5	47.5	---	30.7	ML/CL

File Number: 303276-002 Lab Number: 098305

MAXIMUM DENSITY / OPTIMUM MOISTURE

ASTM D 1557-12 (Modified)

Job Name: Channel Islands High School Relocatables
Sample ID: B 1 @ 0-5'

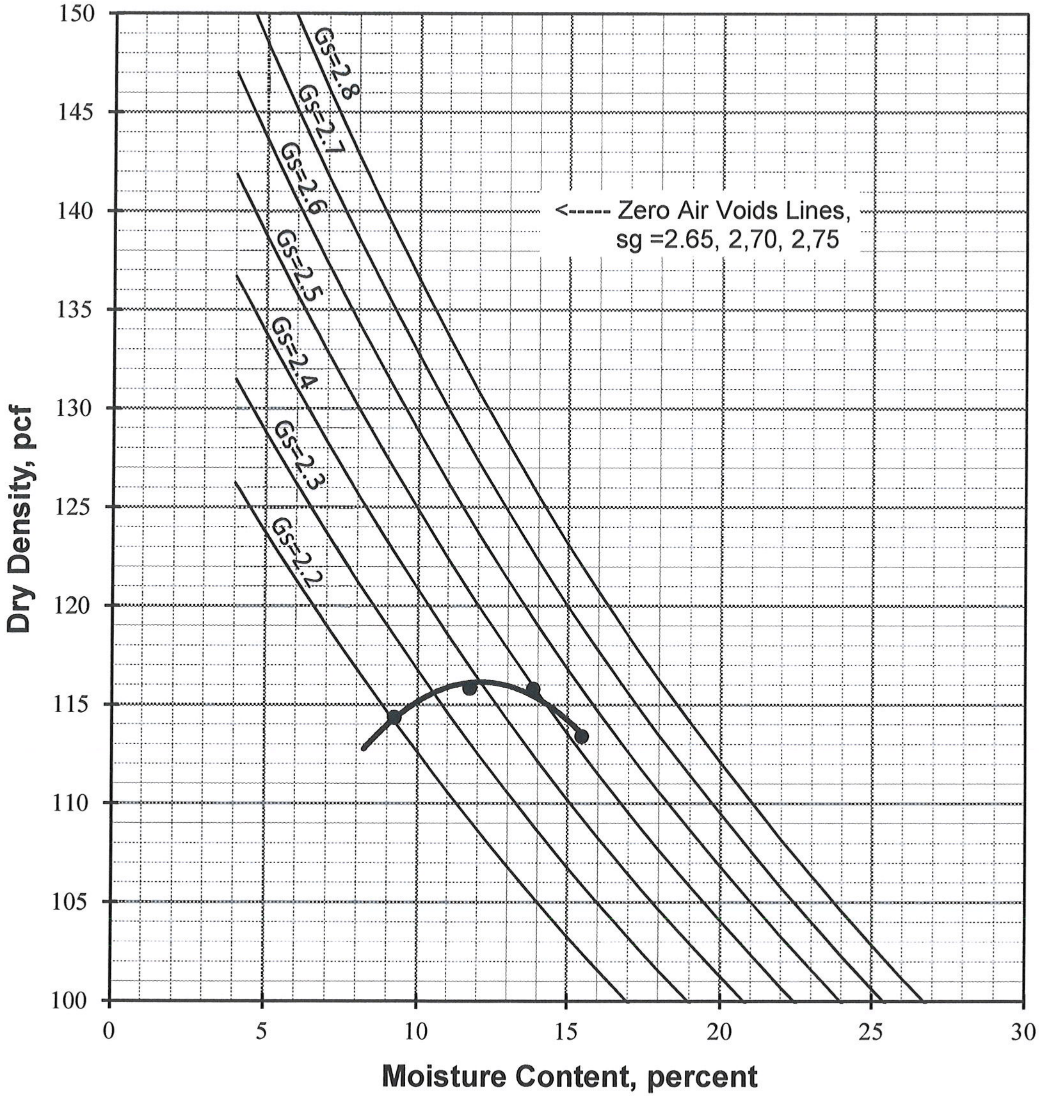
Procedure Used: A
Prep. Method: Moist

Date: 11/5/2019
Description: Brown Sandy Silt
SG: 2.40

Rammer Type: Automatic

Maximum Density: **116 pcf**
Optimum Moisture: **12%**

Sieve Size	% Retained
3/4"	0.0
3/8"	0.0
#4	0.5



File No.: 303276-002

EXPANSION INDEX

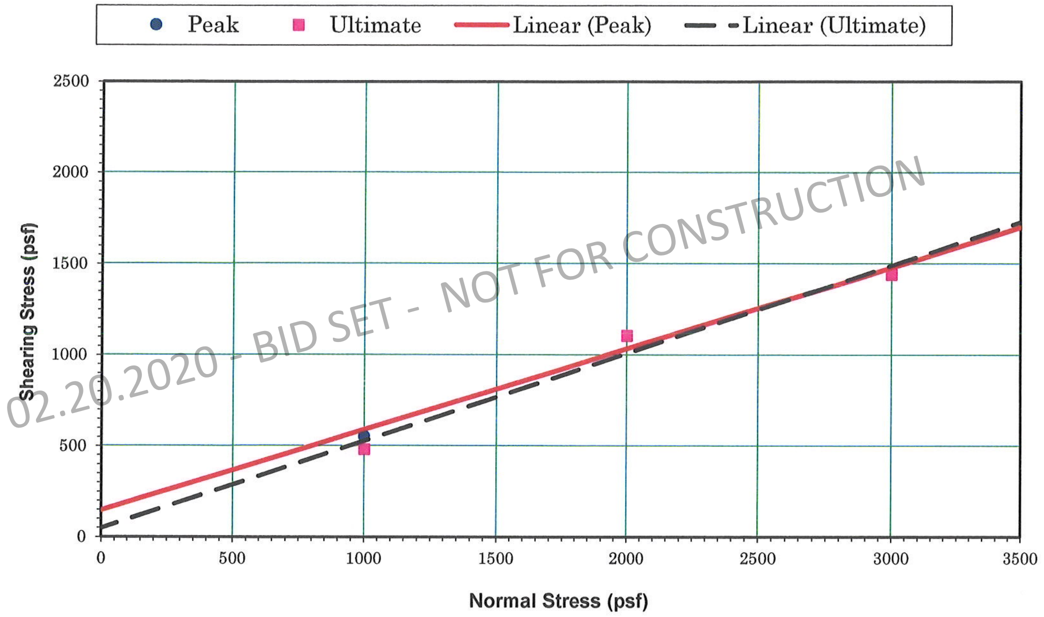
ASTM D-4829, UBC 18-2

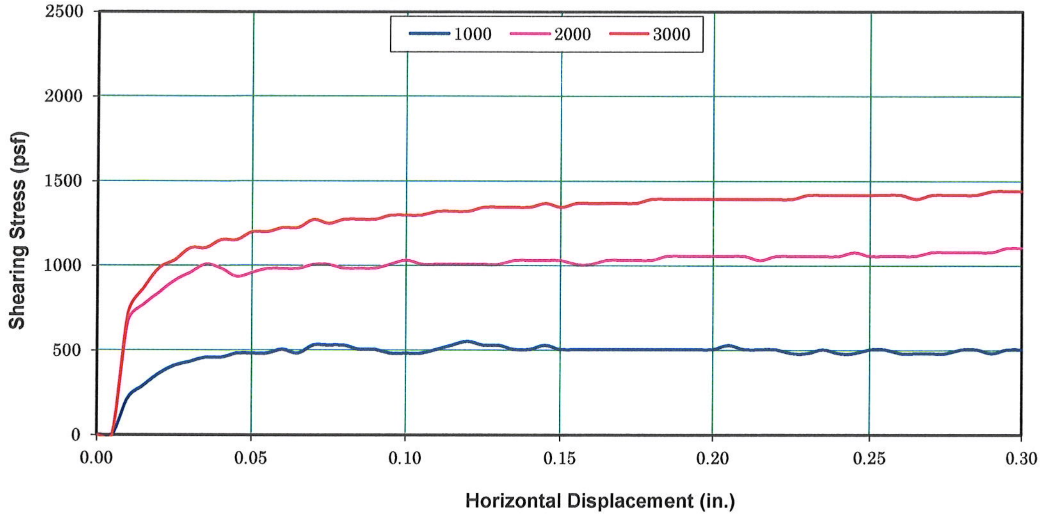
Job Name: Channel Islands H.S. Relocatables
Sample ID: B 1 @ 0-5
Soil Description: ML

Initial Moisture, %:	11.7
Initial Compacted Dry Density, pcf:	104.5
Initial Saturation, %:	52
Final Moisture, %:	25.7
Volumetric Swell, %:	0.0

Expansion Index: **0** **Very Low**

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





DIRECT SHEAR DATA*

Sample Location:	B 1 @ 0-5'
Sample Description:	Sandy Silt
Dry Density (pcf):	103.6
Intial % Moisture:	12.1
Average Degree of Saturation:	100.0
Shear Rate (in/min):	0.005 in/min

Normal stress (psf)	1000	2000	3000
Peak stress (psf)	552	1104	1440
Ultimate stress (psf)	480	1104	1440

	Peak	Ultimate
ϕ Angle of Friction (degrees):	24	26
c Cohesive Strength (psf):	140	40

Test Type: Peak & Ultimate

* Test Method: ASTM D-3080

DIRECT SHEAR TEST

Channel Islands H.S. Relocatables

Earth

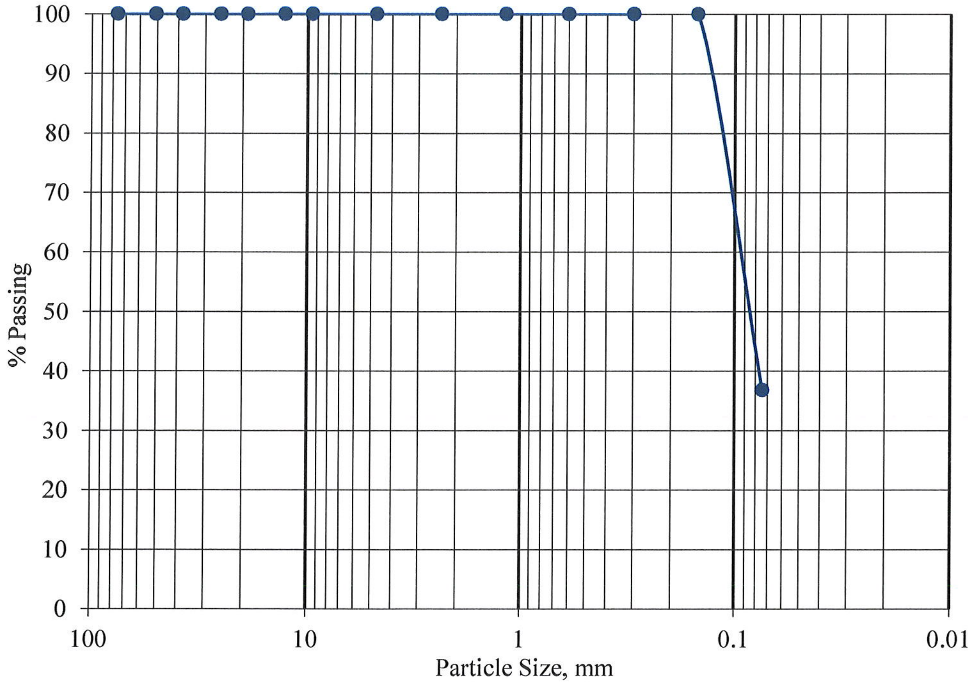
12/13/2019 | 303276-002

SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 2 @ 15'
Description: SC

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	37



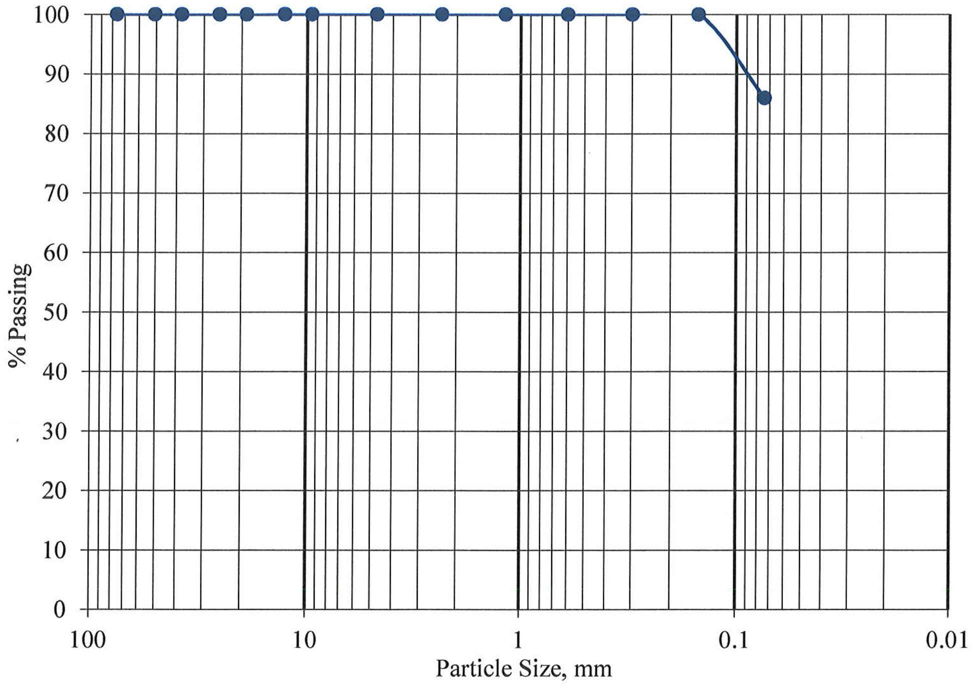
File No.: Channel Islands H.S. Relocatables December 11, 2019

SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 2 @ 35'
Description: ML

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	86

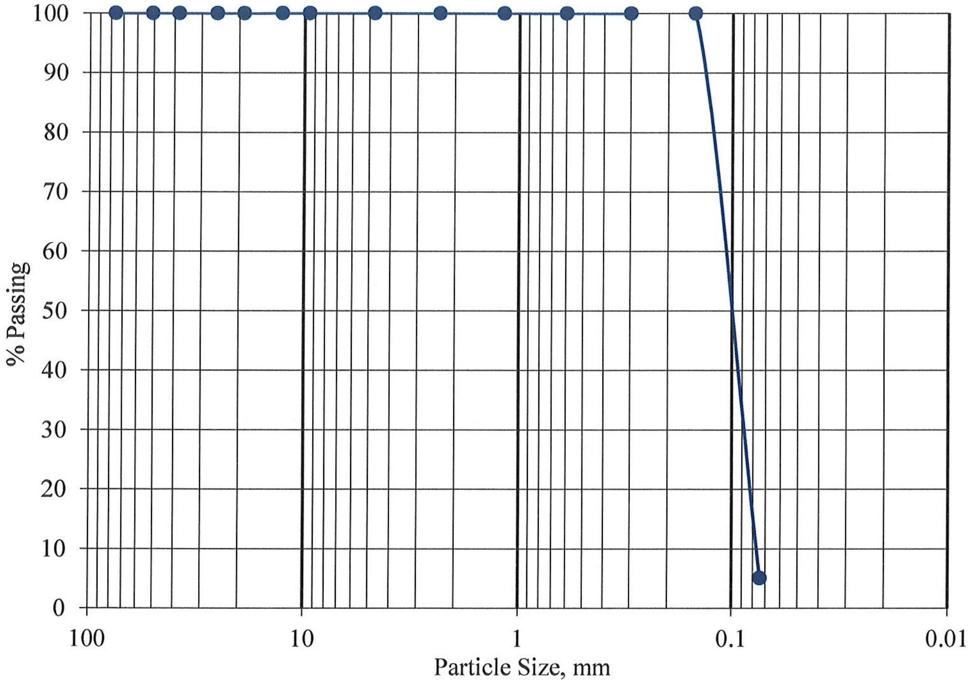


SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 5 @ 15'
Description: SP

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	5

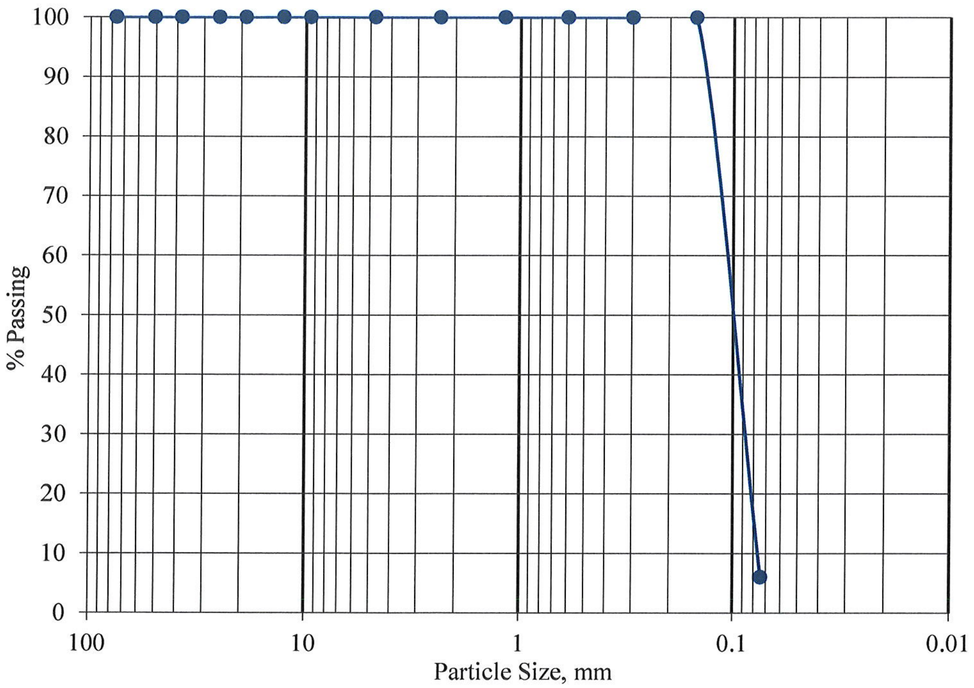


SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 5 @ 22.5'
Description: SP-SM

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	6



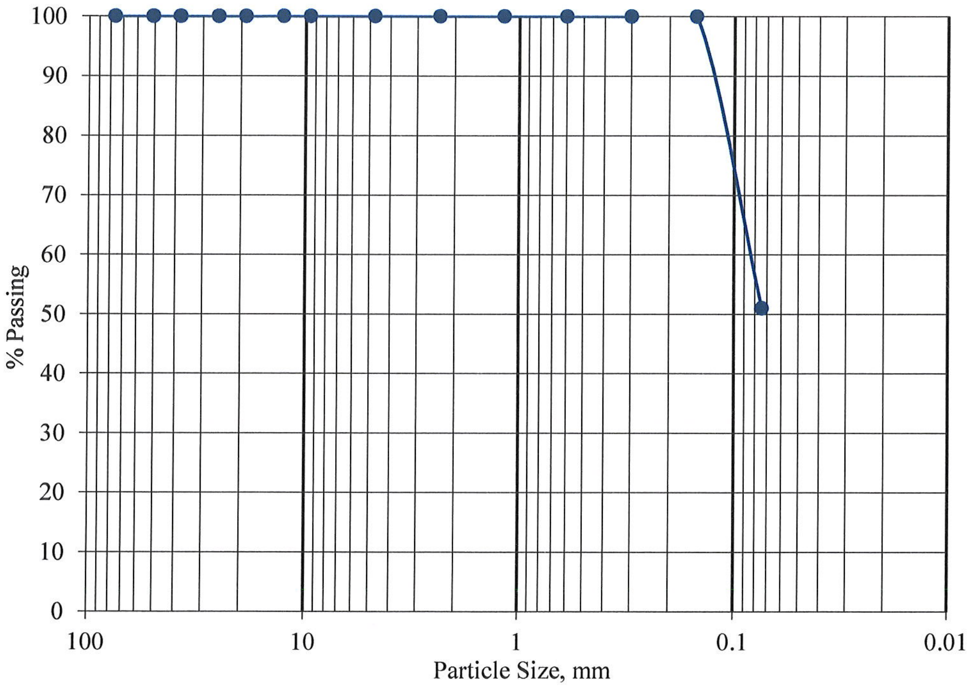
File No.: Channel Islands H.S. Relocatables December 11, 2019

SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 5 @ 27.5'
Description: ML

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	51



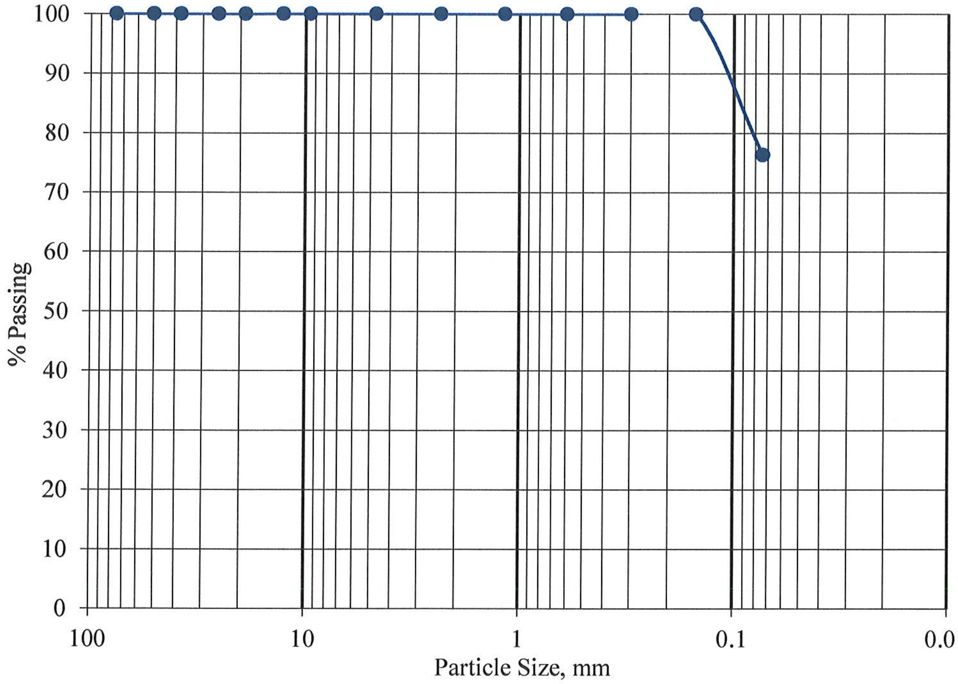
File No.: Channel Islands H.S. Relocatables December 11, 2019

SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 5 @ 32.5'
Description: CL

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	76

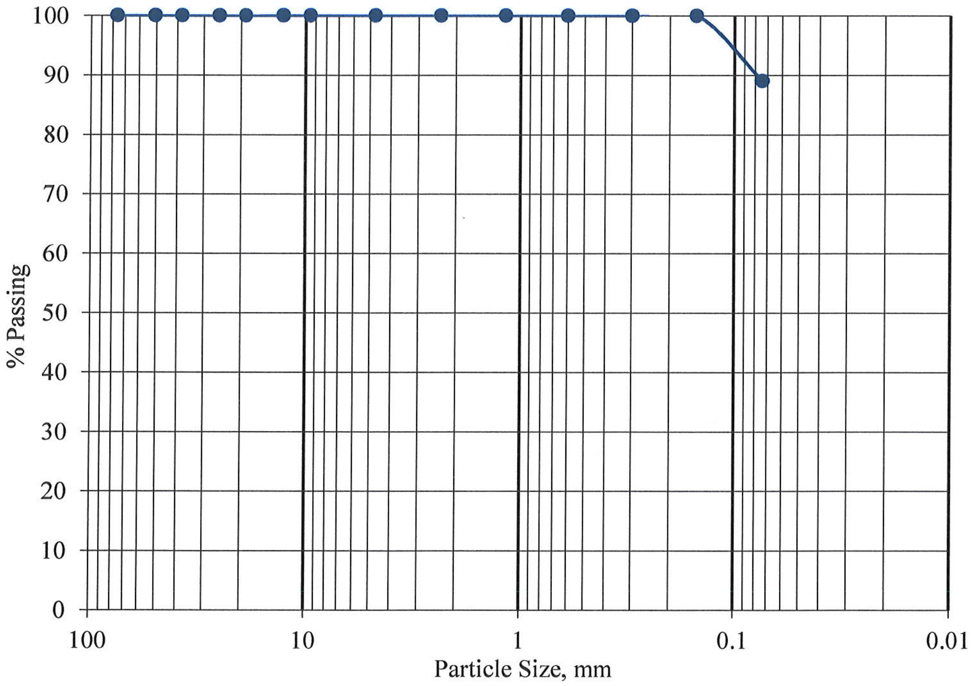


SIEVE ANALYSIS

ASTM C-136

Job Name: 303276-002
Sample ID: B 5 @ 42.5'
Description: ML

Sieve Size	% Passing
3"	100
2"	100
1-1/2"	100
1"	100
3/4"	100
1/2"	100
3/8"	100
#4	100
#8	100
#16	100
#30	100
#50	100
#100	100
#200	89



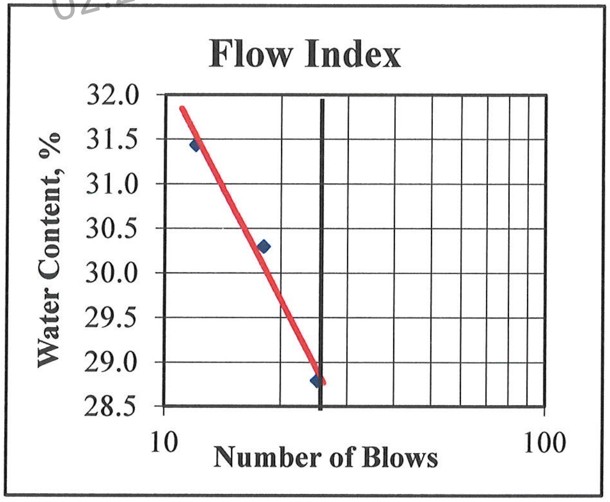
File No.: 303276-002 December 11, 2019

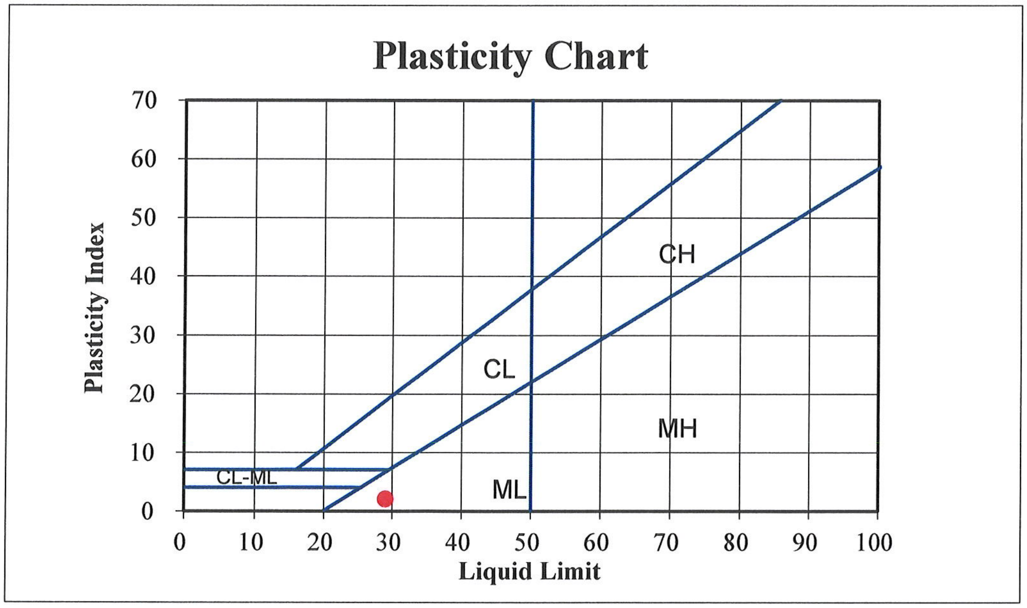
PLASTICITY INDEX

ASTM D-4318

Job Name: Channel Islands H.S. Relocatables
Sample ID: B 2 @ 35'
Soil Description: ML

DATA SUMMARY				**TEST RESULTS**	
Number of Blows:	12	18	25	**LIQUID LIMIT**	**29**
Water Content, %	31.4	30.3	28.8	**PLASTIC LIMIT**	**27**
Plastic Limit:	26.7	26.8		**PLASTICITY INDEX**	**2**





File No.: 303276-002 December 11, 2019

PLASTICITY INDEX

ASTM D-4318

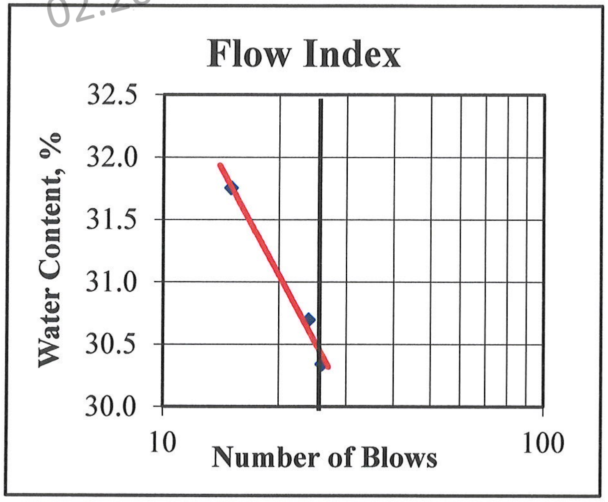
Job Name: Channel Islands H.S. Relocatables
Sample ID: B 5 @ 32.5'
Soil Description: CL

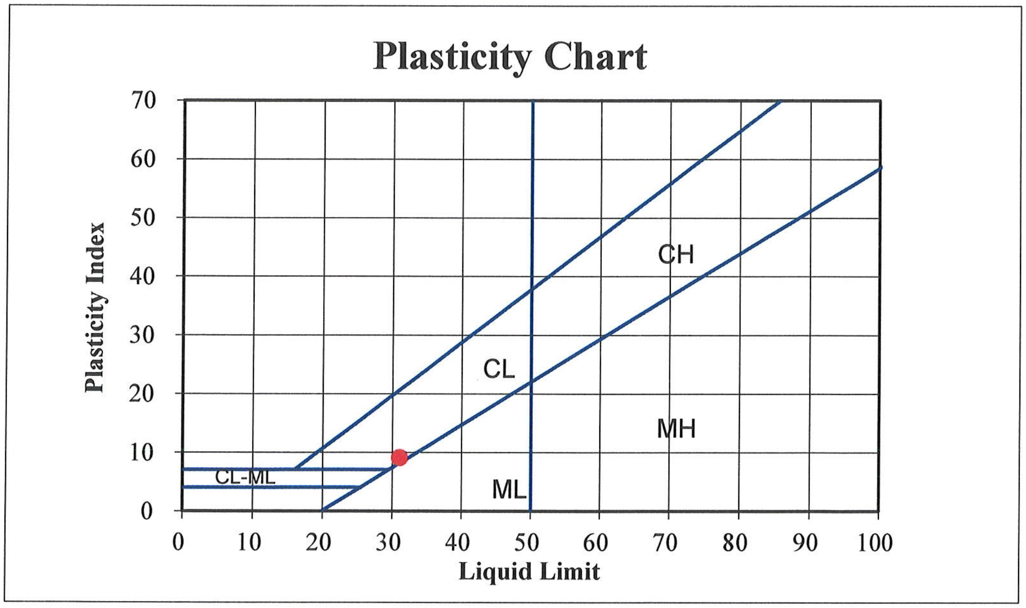
DATA SUMMARY

Number of Blows:	15	24	26
Water Content, %	31.7	30.7	30.3
Plastic Limit:	22.3	22.6	

TEST RESULTS

LIQUID LIMIT	**31**
PLASTIC LIMIT	**22**
PLASTICITY INDEX	**9**





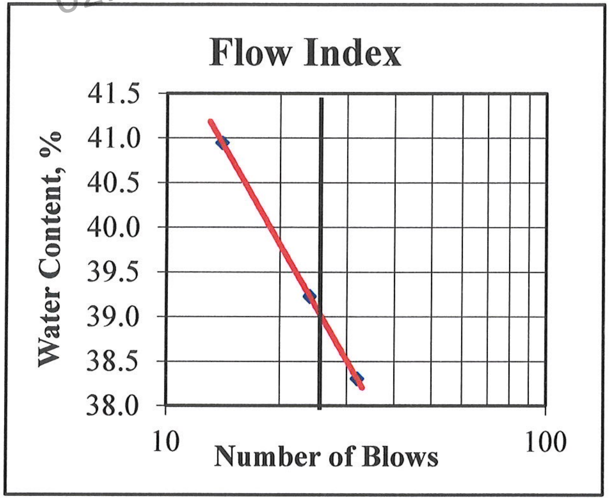
File No.: 303276-002 December 11, 2019

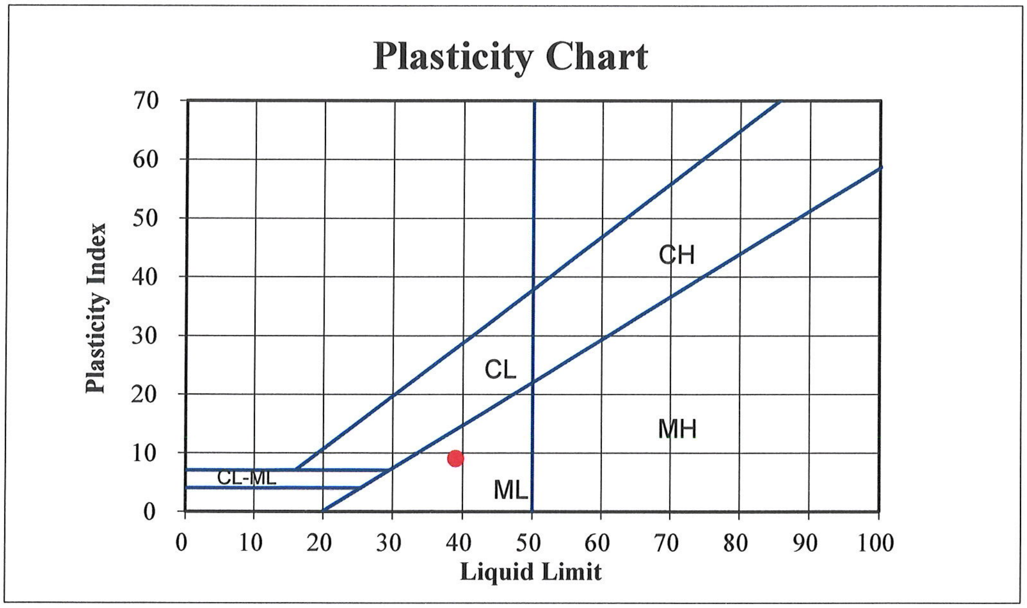
PLASTICITY INDEX

ASTM D-4318

Job Name: Channel Islands H.S. Relocatables
Sample ID: B 5 @ 42.5'
Soil Description: ML

DATA SUMMARY				**TEST RESULTS**	
Number of Blows:	14	24	32	**LIQUID LIMIT**	**39**
Water Content, %	40.9	39.2	38.3	**PLASTIC LIMIT**	**30**
Plastic Limit:	29.9	30.1		**PLASTICITY INDEX**	**9**





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California State Accredited Laboratory in Accordance with ELAP Certificate # 2332

CERTIFICATE OF ANALYSIS

Client: Earth Systems Pacific
CAS LAB NO: 191954-01
Sample ID: B1@0-5'
Analyst: GP

Date Sampled: 10/21/19
Date Received: 10/24/19
Sample Matrix: Soil

WET CHEMISTRY SUMMARY

COMPOUND	RESULTS	UNITS	DF	PQL	METHOD	ANALYZED
pH (Corrosivity)	8.2	S.U.	1	---	9045	10/29/19
Resistivity*	3000	Ohms-cm	1	---	SM 120.1M	10/29/19
Chloride	49	mg/Kg	1	0.3	300.0M	11/05/19
Sulfate	230	mg/Kg	1	0.3	300.0M	11/05/19

*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	FOUNDATIONS FOR SLAB AND RAISED FLOOR SYSTEM (4) (5)							CONCRETE SLABS		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
	NUMBER OF FLOORS	STEM THICKNESS	FOOTING WIDTH	FOOTING THICKNESS	ALL PERIMETER FOOTINGS (5)	INTERIOR FOOTINGS FOR SLAB AND RAISED FLOORS (5)	REINFORCEMENT FOR CONTINUOUS FOUNDATIONS (2)	3 ½ " MINIMUM THICKNESS			
					DEPTH BELOW NATURAL SURFACE OF GROUND AND FINISH GRADE (3) (8)			REINFORCEMENT (3)	TOTAL THICKNESS OF SAND		
		INCHES									
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	6x6-10/10 WWF	4"	130% of optimum moisture required to a depth of 27" below lowest adjacent grade. Testing required.	Piers not allowed.
							#3 BARS @ 24" IN EXT. FOOTING BEND3' INTO SLAB (7)				
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	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.
							#3 BARS @ 24" IN EXT. FOOTING BEND 3' INTO SLAB (7)				
Above 130 Very High	Special design by licensed engineer/architect										

APPENDIX C

Site Classification Calculation
2016 CBC & ASCE 7-10 Seismic Parameters
OSHPD Seismic Design Maps
Spectral Response Values Table
Spectral Response Curves
Fault Parameters

EARTH SYSTEMS

Job Number: 303276-002
Job Name: CIHS Northeast Relocatables
Calc Date: 12/12/2019
CPT/Boring ID: B-2

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
9.5	2.0	9.5	4.750
12.0	20.0	2.5	0.125
14.5	14.0	2.5	0.179
17.0	15.0	2.5	0.167
19.5	15.0	2.5	0.167
22.0	36.0	2.5	0.069
24.5	30.0	2.5	0.083
27.0	23.0	2.5	0.109
29.5	34.0	2.5	0.074
32.0	31.0	2.5	0.081
34.0	31.0	2.0	0.065
37.0	9.0	3.0	0.333
39.5	34.0	2.5	0.074
42.0	46.0	2.5	0.054
47.0	51.0	5.0	0.098
49.5	44.0	2.5	0.057
51.5	26.0	2.0	0.077
100.0	26.0	48.5	1.865

Total Thickness of Soil =	100.00	ft
N-bar Value =	11.9	*
Site Classification =	Class E	

*Equation 20.4-2 of ASCE 7-10

2016 California Building Code (CBC) (ASCE 7-10) Seismic Design Parameters

			CBC Reference	ASCE 7-10 Reference
Seismic Design Category		**E**	Table 1613.5.6	Table 11.6-2
Site Class		**E**	Table 1613.5.2	Table 20.3-1
Latitude:		34.171 N		
Longitude:		-119.161 W		
Maximum Considered Earthquake (MCE) Ground Motion				
Short Period Spectral Reponse	S_S	**2.348 g**	Figure 1613.5	Figure 22-3
1 second Spectral Response	S_1	**0.833 g**	Figure 1613.5	Figure 22.4
Site Coefficient	F_a	0.90	Table 1613.5.3(1)	Table 11.4-1
Site Coefficient	F_v	2.40	Table 1613.5.3(2)	Table 11-4.2
	S_{MS}	2.113 g	$= F_a*S_S$	
	S_{M1}	1.999 g	$= F_v*S_1$	
Design Earthquake Ground Motion				
Short Period Spectral Reponse	S_{DS}	**1.409 g**	$= 2/3*S_{MS}$	
1 second Spectral Response	S_{D1}	**1.333 g**	$= 2/3*S_{M1}$	
	To	0.19 sec	$= 0.2*S_{D1}/S_{DS}$	
	Ts	0.95 sec	$= S_{D1}/S_{DS}$	
Seismic Importance Factor	I	1.25	Table 1604.5	
	F_{PGA}	0.90		

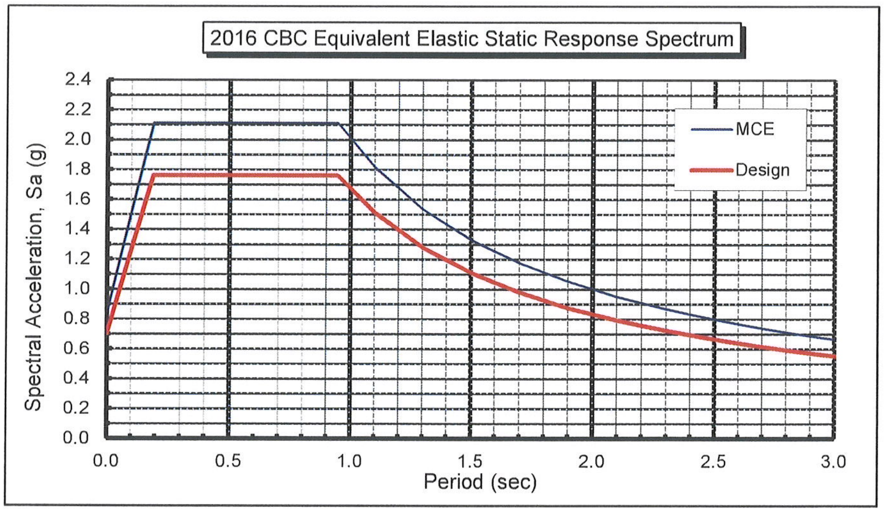


Table 11.5-1

Period T (sec)	Design Sa (g)
0.00	0.704
0.05	0.984
0.19	1.761
0.95	1.761
1.10	1.515
1.30	1.282
1.50	1.111
1.70	0.980
1.90	0.877
2.10	0.793
2.30	0.724
2.50	0.666
2.70	0.617
2.90	0.574
3.10	0.537
3.30	0.505

Channel Islands HS Relocatables

Latitude, Longitude: 34.1710, -119.1608

Date	12/12/2019, 9:47:35 AM
Design Code Reference Document	ASCE7-10
Risk Category	III
Site Class	E - Soft Clay Soil

Type	Value	Description
S_S	2.348	MCE_R ground motion. (for 0.2 second period)
S_1	0.833	MCE_R ground motion. (for 1.0s period)
S_{MS}	2.113	Site-modified spectral acceleration value
S_{M1}	2	Site-modified spectral acceleration value
S_{DS}	1.409	Numeric seismic design value at 0.2 second SA
S_{D1}	1.333	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	E	Seismic design category
F_a	0.9	Site amplification factor at 0.2 second
F_v	2.4	Site amplification factor at 1.0 second
PGA	0.89	MCE_G peak ground acceleration
F_{PGA}	0.9	Site amplification factor at PGA
PGA_M	0.801	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	2.348	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.534	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.648	Factored deterministic acceleration value. (0.2 second)
S1RT	0.833	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.892	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.89	Factored deterministic acceleration value. (1.0 second)
PGAd	0.983	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.927	Mapped value of the risk coefficient at short periods
C_{R1}	0.935	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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 yr MCE Spectrum	Max Rotated Probab. 2% in 50 yr MCEr	Max 84th Percentile Determ. MCE Spectrum	Determ. Lower Limit MCE Spectrum	Determ. MCE Spectrum	**Site Specific MCE Spectrum**	**2016 CBC MCE Spectrum**	Site Specific Design Spectrum	2016 CBC Design Spectrum
	(1) 2475-yr	(2) 2475-yr	(3)	(4)	(5) max(3,4)	(6) min(2.5)	(7)	(8) 2/3*(6)*	(9) 2/3*(7)
0.00	0.696	0.710	0.649	0.540	0.649	**0.649**	**0.845**	0.451	0.564
0.05	0.891	0.909	0.724	0.730	0.730	**0.730**	**1.180**	0.630	0.787
0.10	1.086	1.107	0.946	0.920	0.946	**0.946**	**1.515**	0.808	1.010
0.15	1.270	1.295	1.147	1.110	1.147	**1.147**	**1.850**	0.987	1.234
0.20	1.454	1.483	1.213	1.299	1.299	**1.299**	**2.113**	1.127	1.409
0.30	1.560	1.592	1.299	1.350	1.350	**1.350**	**2.113**	1.127	1.409
0.40	1.539	1.644	1.364	1.350	1.364	**1.364**	**2.113**	1.127	1.409
0.50	1.518	1.694	1.473	1.350	1.473	**1.473**	**2.113**	1.127	1.409
0.75	1.358	1.583	1.613	1.350	1.613	**1.583**	**2.113**	1.127	1.409
1.00	1.198	1.456	1.589	1.350	1.589	**1.456**	**1.999**	1.066	1.333
1.50	0.971	1.180	1.491	0.960	1.491	**1.180**	**1.333**	0.786	0.889
2.00	0.743	0.903	1.332	0.720	1.332	**0.903**	**1.000**	0.602	0.666

Crs: 0.927
Cr1: 0.935

* > 80% of (9)

Probabilistic Spectrum from 2008 USGS Ground Motion Mapping Program adjusted for site conditions and maximum rotated component of ground motion using NGA, Column 2 has risk coefficients Cr applied.

Reference: ASCE 7-10, Chapters 21.2, 21.3, 21.4 and 11.4

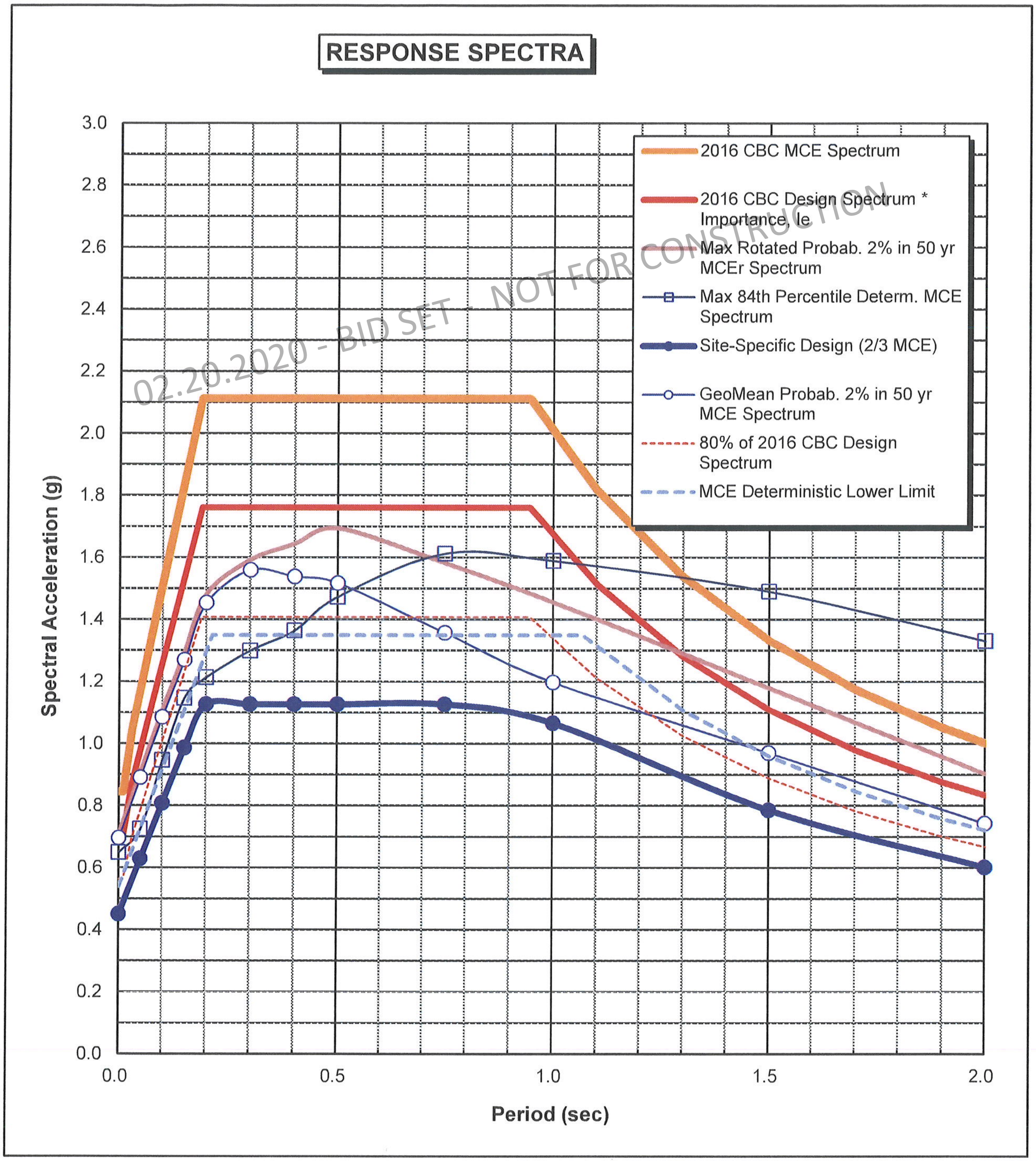
Mapped MCE Acceleration Values			Site Coefficients		**Site-Specific Design Acceleration Values**		
PGA	0.890	g	F_{PGA}	0.90	**PGA_M**	**0.801**	**g**
Ss	2.348	g	F_a	0.90	**S_{DS}**	**1.127**	**g**
S_1	0.833	g	F_v	2.40	**S_{D1}**	**1.204**	**g**

Spectral Amplification Factor for different viscous damping, D (%):

0.5%	2%	10%	20%
1.50	1.23	0.83	0.67

$1\ g = 980.6\ cm/sec^2 = 32.2\ ft/sec^2$
$PSV\ (ft/sec) = 32.2(Sa)T/(2\pi)$

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



Based on USGS National Strong Ground Motion Interactive Deaggregation Website using 2008 Parameters

Site Class: E
Latitude: 34.171
Longitude: -119.1608

Spectral Response Curves

Channel Islands H.S. Relocatables
File No.: 303276-002

Earth Systems

Table 1
Fault Parameters

Fault Section Name	**Distance** (miles)	(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)	2.0	3.2	65	159	90	49	B	**7.4**		4
Simi-Santa Rosa	4.7	7.6	60	346	30	39	B	**6.8**		1
Malibu Coast (Extension), alt 1	7.3	11.8	74	4	30	35	B'	**6.5**		
Malibu Coast (Extension), alt 2	7.3	11.8	74	4	30	35	B'	**6.9**		
Oak Ridge (Offshore)	8.5	13.7	32	180	90	38	B	**6.9**		3
Ventura-Pitas Point	9.0	14.5	64	353	60	44	B	**6.9**		1
Channel Islands Thrust	11.6	18.7	20	354	90	59	B	**7.3**		1.5
Anacapa-Dume, alt 1	13.6	21.9	45	354	60	51	B	**7.2**		3
Anacapa-Dume, alt 2	13.6	21.9	41	352	60	65	B	**7.2**		3
Red Mountain	14.2	22.8	56	2	90	101	B	**7.4**		2
Santa Cruz Island	14.2	22.8	90	188	30	69	B	**7.1**		1
Malibu Coast, alt 1	15.6	25.1	75	3	30	38	B	**6.6**		0.3
Malibu Coast, alt 2	15.6	25.1	74	3	30	38	B	**6.9**		0.3
Channel Islands Western Deep Ramp	15.7	25.3	21	204	90	62	B'	**7.3**		
Sisar	16.9	27.2	29	168	na	20	B'	**7.0**		
Pitas Point (Lower)-Montalvo	18.1	29.1	16	359	90	30	B	**7.3**		2.5
North Channel	18.2	29.3	26	10	90	51	B	**6.7**		1
San Cayetano	18.4	29.6	42	3	90	42	B	**7.2**		6
Shelf (Projection)	18.5	29.7	17	21	na	70	B'	**7.8**		
Mission Ridge-Arroyo Parida-Santa Ana	19.2	31.0	70	176	90	69	B	**6.8**		0.4
Santa Cruz Catalina Ridge	22.4	36.1	90	38	na	137	B'	**7.3**		
Santa Monica Bay	24.8	40.0	20	44	na	17	B'	**7.0**		
Santa Ynez (East)	24.9	40.0	70	172	0	68	B	**7.2**		2
Pitas Point (Upper)	25.9	41.6	42	15	90	35	B	**6.8**		1
Santa Susana, alt 1	26.0	41.8	55	9	90	27	B	**6.8**		5
San Pedro Basin	26.2	42.1	88	51	na	69	B'	**7.0**		
Santa Susana, alt 2	26.2	42.2	53	10	90	43	B'	**6.8**		
Northridge Hills	27.5	44.2	31	19	90	25	B'	**7.0**		
Pine Mtn	28.1	45.2	45	5	na	62	B'	**7.3**		
Del Valle	29.3	47.2	73	195	90	9	B'	**6.3**		
Holser, alt 1	29.7	47.8	58	187	90	20	B	**6.7**		0.4
Holser, alt 2	29.7	47.8	58	182	90	17	B'	**6.7**		
Oak Ridge (Offshore), west extension	30.0	48.3	67	195	na	28	B'	**6.1**		
Northridge	30.7	49.5	35	201	90	33	B	**6.8**		1.5
Compton	32.8	52.8	20	34	90	65	B'	**7.5**		
San Pedro Escarpment	33.7	54.2	17	38	na	27	B'	**7.3**		
Santa Ynez (West)	35.3	56.8	70	182	0	63	B	**6.9**		2
Pitas Point (Lower, West)	35.4	56.9	13	3	90	35	B	**7.2**		2.5
Santa Monica, alt 1	36.0	57.9	75	343	30	14	B	**6.5**		1
Big Pine (Central)	36.2	58.3	76	167	na	23	B'	**6.3**		

Reference: USGS OFR 2007-1437 (CGS SP 203) Based on Site Coordinates of 34.171 Latitude, -119.1608 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 and Dry Sand Seismic Settlement Analyses
Lateral Spreading Analyses Results

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: Channel Islands H.S. Relocatables
Job No: 303276-002
Date: 12/13/2019
Boring: B-2 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: 7.4 7.5
PGA, g: 0.80 0.77
MSF: 1.03
GWT: 11.0 feet
Calc GWT: 5.0 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

Total (ft) Subsidence Thickness	Total (in.) Liquefaction Subsidence	Total (in.) Dry Sand Subsidence
15	3.5	0.7

Threshold Acceler., g: 0.12
Required SF: 1.25
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 $N_{1(60)CS}$	$K\sigma$	M = 7.5 Available CRR	M =7.5 Induced CSR*	Liquefac. Safety Factor	Post FC Adj. $\Delta N_{1(60)}$	Post $N_{1(60)CS}$	Volumetric Strain (%)	Induced Subsidence (in.)
0.0				0				0.000																	
2.0	0	2	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.10	3.1	21	5.6	8.7	1.00	0.095	0.642	0.15	2.8	5.9	4.83	0.00
5.0	0	2	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.10	3.1	21	5.6	8.7	1.00	0.095	0.642	0.15	2.8	5.9	4.83	0.00
11.0	0	2	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.10	3.1	21	5.6	8.7	1.00	0.095	0.642	0.15	2.8	5.9	3.59	2.59
12.0	0	20	1	120	35	11.5	14.5	0.690	0.674	0.98	1.25	0.80	1.30	34.5	70	10.0	44.5	1.00	1.200	0.696	1.73	10.0	44.5	0.00	0.00
14.5	0	14	1	120	35	14.0	17.0	0.840	0.746	0.97	1.19	0.85	1.23	23.1	57	9.6	32.7	1.00	1.200	0.734	1.64	9.6	32.7	0.47	0.00
17.0	0	15	1	120	37	16.5	19.5	0.990	0.818	0.97	1.14	0.89	1.24	25.1	60	10.0	35.1	1.00	1.200	0.762	1.58	10.0	35.1	0.00	0.00
20.0	0	15	1	120	35	19.0	22.0	1.140	0.890	0.96	1.09	0.92	1.24	24.9	60	10.0	34.9	1.00	1.200	0.783	1.53	10.0	34.9	0.00	0.00
22.0	0	36	1	120	35	21.5	24.5	1.290	0.962	0.95	1.05	0.95	1.30	62.2	94	10.0	72.2	1.00	1.200	0.798	1.50	10.0	72.2	0.00	0.00
24.5	0	30	1	120	35	24.0	27.0	1.440	1.034	0.95	1.01	0.97	1.30	51.3	86	10.0	61.3	1.00	1.200	0.809	1.48	10.0	61.3	0.00	0.00
27.0	0	23	1	120	5	26.5	29.5	1.590	1.106	0.94	0.98	1.00	1.30	38.8	74	0.0	38.8	1.00	1.200	0.815	1.47	0.0	38.8	0.00	0.00
29.5	0	34	0	120	80	29.0	32.0	1.740	1.178	0.93	1.00	1.00	1.30	58.9				1.00	Infin.	0.818	Non-Liq.		58.9	0.00	0.00
33.0	0	31	1	120	55	31.5	34.5	1.890	1.250	0.91	0.92	1.00	1.30	49.4	84	10.0	59.4	1.00	1.200	0.818	1.47	10.0	59.4	0.00	0.00
37.0	0	9	1	120	86	36.5	39.5	2.190	1.394	0.88	0.87	1.00	1.13	11.8	41	7.4	19.1	0.97	0.206	0.825	0.25	5.0	16.8	1.82	0.87
40.0	0	34	1	120	55	39.0	42.0	2.340	1.466	0.86	0.85	1.00	1.30	50.1	85	10.0	60.1	0.93	1.200	0.854	1.41	10.0	60.1	0.00	0.00
42.0	0	46	1	120	35	41.5	44.5	2.490	1.538	0.84	0.83	1.00	1.30	66.1	97	10.0	76.1	0.91	1.200	0.856	1.40	10.0	76.1	0.00	0.00
45.0	0	46	1	120	5	44.0	47.0	2.640	1.610	0.81	0.81	1.00	1.30	64.6	96	0.0	64.6	0.89	1.200	0.855	1.40	0.0	64.6	0.00	0.00
47.0	0	51	1	120	5	46.5	49.5	2.790	1.682	0.79	0.79	1.00	1.30	70.1	###	0.0	70.1	0.87	1.200	0.850	1.41	0.0	70.1	0.00	0.00
49.5	0	44	1	120	5	49.0	52.0	2.940	1.754	0.76	0.78	1.00	1.30	59.2	92	0.0	59.2	0.85	1.200	0.843	1.42	0.0	59.2	0.00	0.00
51.5	0	26	0	120	70	51.5	54.5	3.090	1.826	0.74	1.00	1.00	1.30	45.1				0.92	Infin.	0.764	Non-Liq.		45.1	0.00	0.00

SETTLEMENT (SUBSIDENCE) OF DRY SANDS

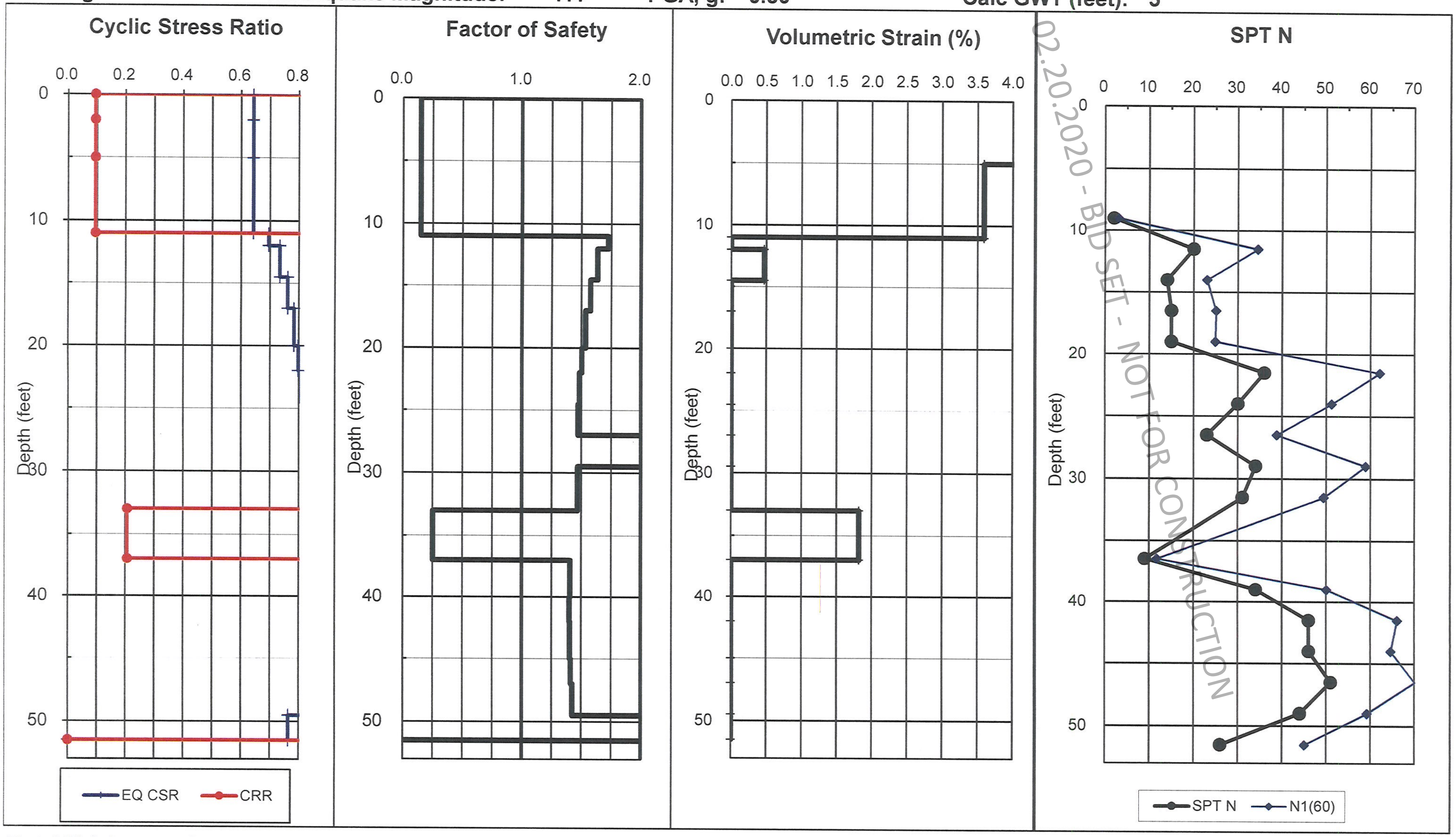
Nc = 14.2

p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	tav/Gmax	a	b	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
0.362	553	0.184	0.0003	0.138	11,779	2.3E-03	6.3E-03	6.2E-03	0.30
0.362	553	0.184	0.0003	0.138	11,779	2.3E-03	6.3E-03	6.2E-03	0.44
0.362	553	0.184	0.0003	0.138	11,779	2.3E-03			
0.462	1,077	0.234	0.0002	0.142	10,168	4.3E-04			
0.563	1,072	0.283	0.0003	0.146	9,036	6.0E-04			
0.663	1,192	0.332	0.0003	0.150	8,188	6.0E-04			
0.764	1,277	0.380	0.0003	0.154	7,523	6.3E-04			
0.864	1,730	0.427	0.0002	0.158	6,985	4.0E-04			
0.965	1,731	0.472	0.0003	0.162	6,539	4.6E-04			
1.065	1,562	0.517	0.0003	0.165	6,162	6.4E-04			
1.166				0.169	5,837				
1.266	1,963	0.599	0.0003	0.173	5,555	5.1E-04			
1.467	1,448	0.669	0.0005	0.181	5,085	1.1E-03			
1.568	2,192	0.698	0.0003	0.185	4,887	5.0E-04			
1.668	2,447	0.724	0.0003	0.189	4,708	4.4E-04			
1.769	2,386	0.745	0.0003	0.193	4,545	4.7E-04			
1.869	2,520	0.764	0.0003	0.197	4,397	4.4E-04			
1.970	2,445	0.779	0.0003	0.201	4,261	4.7E-04			
2.070				0.205	4,136				

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Channel Islands H.S. Relocatables **Project No: 303276-002** 1996/1998 NCEER Method

Boring: B-2 **Earthquake Magnitude: 7.4** **PGA, g: 0.80** **Calc GWT (feet): 5**



Total Thickness of Liquefiable Layers: 15.0 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: **Channel Islands H.S. Relocatables**
Job No: **303276-002**
Date: **12/13/2019**
Boring: **B-2** 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: **7.4** 7.5
PGA, g: **0.80** 0.77
MSF: 1.03
GWT: **11.0** feet
Calc GWT: **5.0** feet
Remediate to: **5.0** **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

Total (ft) Subsidence Thickness	Total (in.) Liquefaction Subsidence	Total (in.) Dry Sand Subsidence
10	3.5	0.0

Threshold Acceler., g: **0.12**
Required SF: 1.25
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* $N_{1(60)CS}$	$K\sigma$	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																	
2.0	0	**50**	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.30	91.0	###	10.0	#####	1.00	1.200	0.642	**1.87**	10.0	#####	0.01	**0.00**
5.0	0	**50**	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.30	91.0	###	10.0	#####	1.00	1.200	0.642	**1.87**	10.0	#####	0.01	**0.00**
11.0	0	2	1	120	35	9.0	12.0	0.540	0.540	0.98	1.40	0.75	1.10	3.1	21	5.6	8.7	1.00	0.095	0.642	**0.15**	2.8	5.9	3.59	**2.59**
12.0	0	20	1	120	35	11.5	14.5	0.690	0.674	0.98	1.25	0.80	1.30	34.5	70	10.0	44.5	1.00	1.200	0.696	**1.73**	10.0	44.5	0.00	**0.00**
14.5	0	14	1	120	35	14.0	17.0	0.840	0.746	0.97	1.19	0.85	1.23	23.1	57	9.6	32.7	1.00	1.200	0.734	**1.64**	9.6	32.7	0.47	**0.00**
17.0	0	15	1	120	37	16.5	19.5	0.990	0.818	0.97	1.14	0.89	1.24	25.1	60	10.0	35.1	1.00	1.200	0.762	**1.58**	10.0	35.1	0.00	**0.00**
20.0	0	15	1	120	35	19.0	22.0	1.140	0.890	0.96	1.09	0.92	1.24	24.9	60	10.0	34.9	1.00	1.200	0.783	**1.53**	10.0	34.9	0.00	**0.00**
22.0	0	36	1	120	35	21.5	24.5	1.290	0.962	0.95	1.05	0.95	1.30	62.2	94	10.0	72.2	1.00	1.200	0.798	**1.50**	10.0	72.2	0.00	**0.00**
24.5	0	30	1	120	35	24.0	27.0	1.440	1.034	0.95	1.01	0.97	1.30	51.3	86	10.0	61.3	1.00	1.200	0.809	**1.48**	10.0	61.3	0.00	**0.00**
27.0	0	23	1	120	5	26.5	29.5	1.590	1.106	0.94	0.98	1.00	1.30	38.8	74	0.0	38.8	1.00	1.200	0.815	**1.47**	0.0	38.8	0.00	**0.00**
29.5	0	34	0	120	80	29.0	32.0	1.740	1.178	0.93	1.00	1.00	1.30	58.9				1.00	Infin.	0.818	**Non-Liq.**		58.9	0.00	**0.00**
33.0	0	31	1	120	55	31.5	34.5	1.890	1.250	0.91	0.92	1.00	1.30	49.4	84	10.0	59.4	1.00	1.200	0.818	**1.47**	10.0	59.4	0.00	**0.00**
37.0	0	9	1	120	86	36.5	39.5	2.190	1.394	0.88	0.87	1.00	1.13	11.8	41	7.4	19.1	0.97	0.206	0.825	**0.25**	5.0	16.8	1.82	**0.87**
40.0	0	34	1	120	55	39.0	42.0	2.340	1.466	0.86	0.85	1.00	1.30	50.1	85	10.0	60.1	0.93	1.200	0.854	**1.41**	10.0	60.1	0.00	**0.00**
42.0	0	46	1	120	35	41.5	44.5	2.490	1.538	0.84	0.83	1.00	1.30	66.1	97	10.0	76.1	0.91	1.200	0.856	**1.40**	10.0	76.1	0.00	**0.00**
45.0	0	46	1	120	5	44.0	47.0	2.640	1.610	0.81	0.81	1.00	1.30	64.6	96	0.0	64.6	0.89	1.200	0.855	**1.40**	0.0	64.6	0.00	**0.00**
47.0	0	51	1	120	5	46.5	49.5	2.790	1.682	0.79	0.79	1.00	1.30	70.1	###	0.0	70.1	0.87	1.200	0.850	**1.41**	0.0	70.1	0.00	**0.00**
49.5	0	44	1	120	5	49.0	52.0	2.940	1.754	0.76	0.78	1.00	1.30	59.2	92	0.0	59.2	0.85	1.200	0.843	**1.42**	0.0	59.2	0.00	**0.00**
51.5	0	26	0	120	70	51.5	54.5	3.090	1.826	0.74	1.00	1.00	1.30	45.1				0.92	Infin.	0.764	**Non-Liq.**		45.1	0.00	**0.00**

SETTLEMENT (SUBSIDENCE) OF DRY SANDS

Nc = 14.2

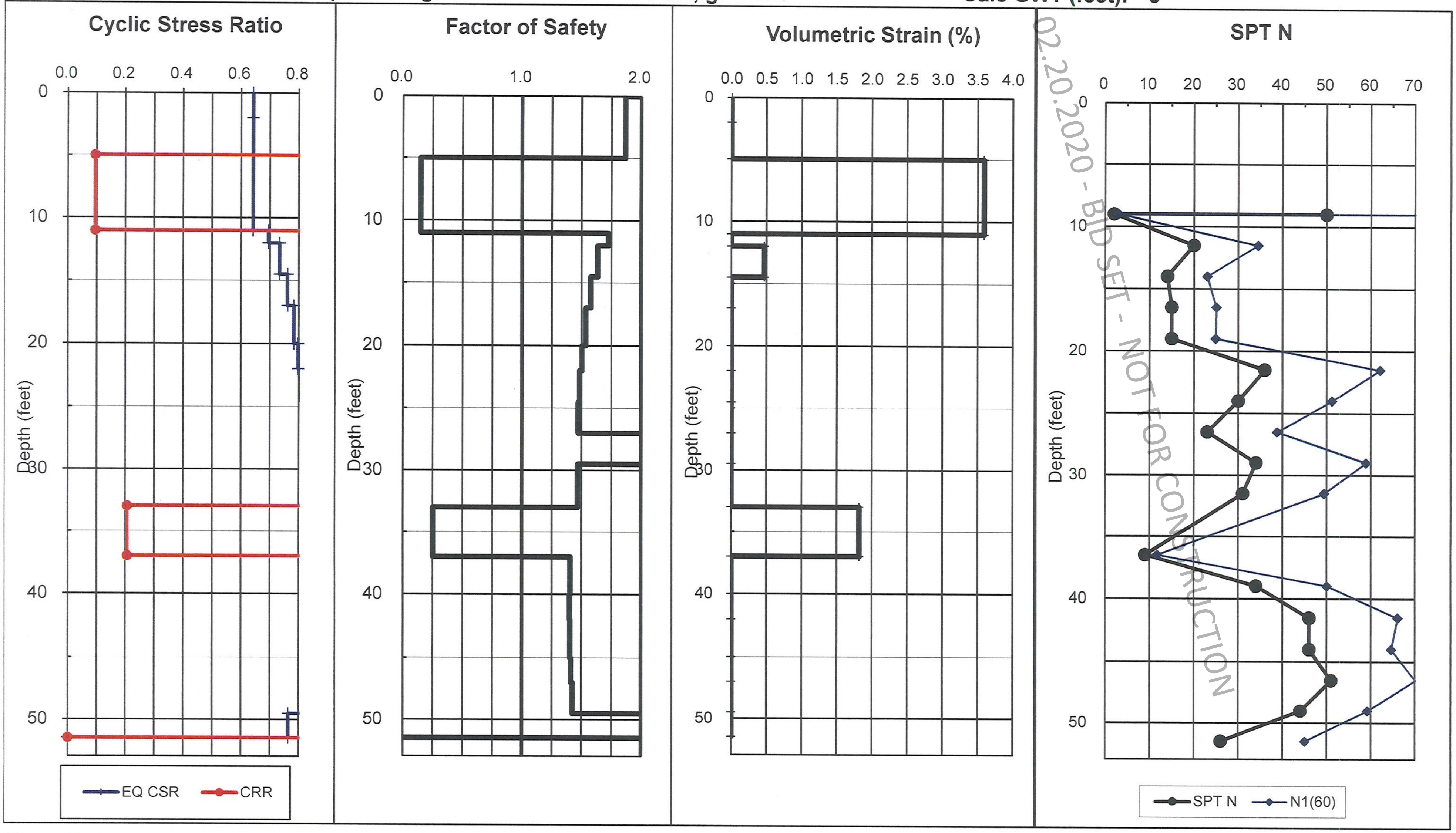
Base Depth (feet)	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	tav/Gmax	a	b	Shear Strain γ	Strain E_{15}	Strain Enc	**Dry Sand Subsidence (in.)**
2.0	0.362	1,252	0.184	0.0001	0.138	11,779	2.3E-04	3.3E-05	3.2E-05	**0.00**
5.0	0.362	1,252	0.184	0.0001	0.138	11,779	2.3E-04	3.3E-05	3.2E-05	**0.00**
11.0	0.362	553	0.184	0.0003	0.138	11,779	2.3E-03			
12.0	0.462	1,077	0.234	0.0002	0.142	10,168	4.3E-04			
14.5	0.563	1,072	0.283	0.0003	0.146	9,036	6.0E-04			
17.0	0.663	1,192	0.332	0.0003	0.150	8,188	6.0E-04			
20.0	0.764	1,277	0.380	0.0003	0.154	7,523	6.3E-04			
22.0	0.864	1,730	0.427	0.0002	0.158	6,985	4.0E-04			
24.5	0.965	1,731	0.472	0.0003	0.162	6,539	4.6E-04			
27.0	1.065	1,562	0.517	0.0003	0.165	6,162	6.4E-04			
29.5	1.166				0.169	5,837				
33.0	1.266	1,963	0.599	0.0003	0.173	5,555	5.1E-04			
37.0	1.467	1,448	0.669	0.0005	0.181	5,085	1.1E-03			
40.0	1.568	2,192	0.698	0.0003	0.185	4,887	5.0E-04			
42.0	1.668	2,447	0.724	0.0003	0.189	4,708	4.4E-04			
45.0	1.769	2,386	0.745	0.0003	0.193	4,545	4.7E-04			
47.0	1.869	2,520	0.764	0.0003	0.197	4,397	4.4E-04			
49.5	1.970	2,445	0.779	0.0003	0.201	4,261	4.7E-04			
51.5	2.070				0.205	4,136				

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Channel Islands H.S. Relocatables **Project No: 303276-002**

1996/1998 NCEER Method
Ground Compaction Remediated to 5 foot depth

Boring: B-2 **Earthquake Magnitude: 7.4** **PGA, g: 0.80** **Calc GWT (feet): 5**



Total Thickness of Liquefiable Layers: 10.0 feet

Estimated Total Ground Subsidence: 3.5 inches

Job Number: 303276-002
Job Name: Channel Islands HS Relocatables
Boring Number: B-2
Date: December 11, 2019
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 $(D50_{15})$

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

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 = 7.1	
R = 11.18	km
S = 0.2	%
T_{15} = 3.1	m
F_{15} = 30	%
$D50_{15}$ = 0.1	mm

Horizontal Ground Displacement in meters (D_H) = 0.53
Horizontal Ground Displacement in feet (D_H) = 1.7

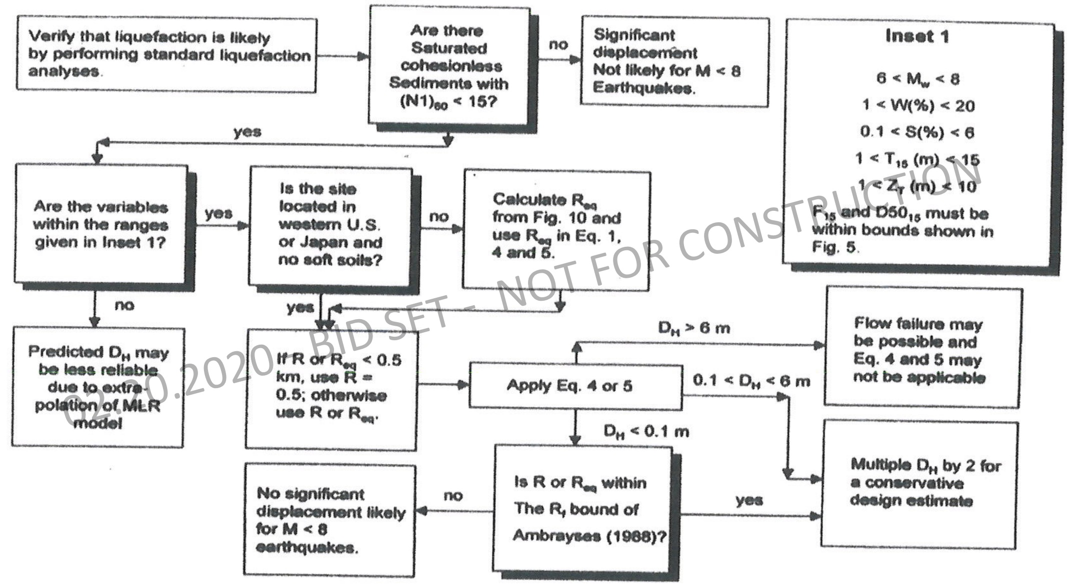


Fig. 9. Flow chart [for application of Eq. (6)]

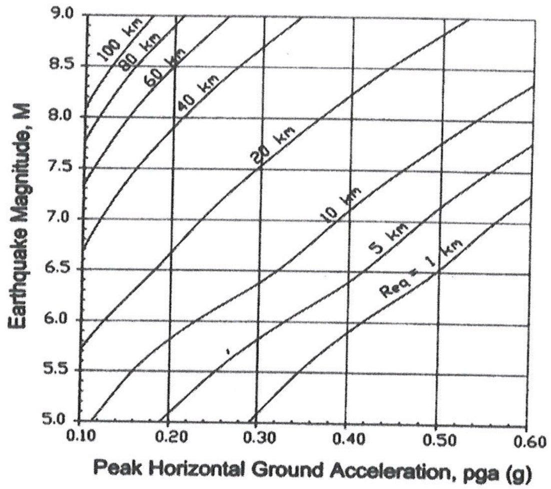


Fig. 10. Graph for determining equivalent source distance, R_{eq}, from magnitude, M, and peak acceleration, a_{max} (revised from Bartlett and Youd 1992, 1995). The above curves are the averages of pga from three different attenuation relations: Abrahamson and Silva (1997); Boore et al. (1997); and Campbell (1997). For the Abrahamson and Silva (1997) relation, the following parameters were used in the regression equation: a) R equals the distance to the fault rupture, b) fault type was set to "otherwise", c) HW=hanging wall factor was set to 1, which implies that sites are found on the hanging wall, d) site classification was set to 1 for deep soil sites. For the Boore, Joyner and Fumal (1997) relation, the following parameters were used in the regression equation: a) R is the closest horizontal distance (km) to a vertical projection of fault rupture surface (km), b) Vs in the upper 30 meters was set to 270 m/s, which is the mid range for a medium stiff soil (site class D), c) fault type was set to "fault mechanism not specified." For the Campbell (1997) relation, the following parameters were used in the regression equation: a) R is the closest distance to the seismogenic rupture surface (km), b) fault style factor was set to "otherwise", c) soft rock and hard rock site factors were set to "otherwise", which implies a stiff soil site.

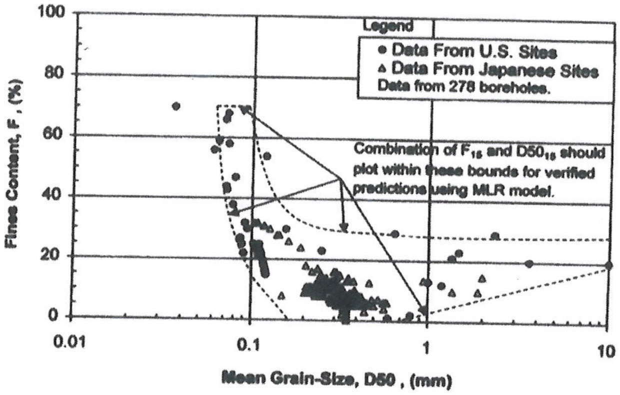


Fig. 5. Compiled grain-size data with ranges of F_{15} and $D50_{15}$ [for which Eq. (6) is applicable]