ENGINEERING GEOLOGY AND
GEOTECHNICAL ENGINEERING REPORT
FOR PROPOSED HOME BLEACHERS,
RIO MESA HIGH SCHOOL,
545 CENTRAL AVENUE,
OXNARD AREA,
VENTURA COUNTY, CALIFORNIA

PROJECT NO.: 303280-002
FEBRUARY 20, 2020

PREPARED FOR
OXNARD UNION HIGH SCHOOL DISTRICT

BY
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Project No.: 303280-002
Report No.: 20-2-63

Attention: Poul Hanson
Oxnard Union High School District
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Oxnard, CA 93030

Project: Rio Mesa High School Home Bleachers
545 Central Avenue
Oxnard Area, Ventura County, California

As authorized, we have performed a geotechnical study for proposed replacement bleachers to be located on the campus of Rio Mesa High School in the Oxnard area of Ventura County, 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-19-12-012 dated December 19, 2019, and authorized by Purchase Order No. A20-02445 on 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 Rio Mesa High School in the Oxnard area of Ventura County, California. Although detailed plans are not available at this time, it is our understanding that the bleachers will have a footprint of 15,200 square feet and will replace existing bleachers on the southwest (home) side of the football field.

The Rio Mesa High School campus is located at 545 Central Avenue in the Oxnard area (see Vicinity Map in Appendix A). The coordinates of the site are 34.2556° north latitude and 119.1448° west longitude. The new bleachers will be located in the same location as the existing bleachers; however, it appears that the bleachers will extend into the adjacent relatively flat grass areas. There are no springs or seeps on the property.

Based on interpretation of the USGS 7.5-Minute Saticoy Quadrangle, slope gradients near the site are about 0.48%, or 10 feet over 2,100 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 stereographic pair of aerial photographs taken of the site and surrounding areas on October 25, 1945 by Fairchild Aerial Surveys, Inc.
3. Reviewing pertinent geologic literature.
4. Drilling, sampling, and logging of two (2) hollow-stem auger borings to study geologic, soil, and groundwater conditions.
5. Advancing two cone penetration test (CPT) soundings to further evaluate subsurface stratigraphy.
6. Laboratory testing of soil samples obtained from the subsurface exploration to determine their physical and engineering properties.
7. Consulting with owner representatives and design professionals.
8. Analyzing the geotechnical data obtained.
9. 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. Regional Geology

The site lies within the Oxnard Plain area of the Ventura basin in the western portion of the Transverse Ranges geologic province. Numerous east-west trending folds and reverse faults indicative of ongoing north-south transpressional tectonics characterize the region. Ongoing folding and uplift have tilted Pleistocene to Tertiary age sedimentary rocks in the region.

The Rio Mesa 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). The surface trace of the Oak Ridge (Onshore) fault is the nearest fault to the site. Portions of this fault are considered to be ”active” by the California Geological Survey. It is a south dipping reverse fault that generally parallels the south side of the Santa Clara River Valley. At its closest position to the school site (approximately 0.93 miles to the northwest of the campus), it is mapped as buried by alluvium. When considering the fault dips at about 65°, at depth the fault plane could be considered to be 0.88 miles from the rupture plane at its nearest point.

The Rio Mesa High School campus is not located within any of the Seismic-Induced Landslide Areas designated by the California Geological Survey (CGS, 2003b), 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 deposits (Qal). Units encountered within the test borings and CPT soundings consisted primarily of clean sands with some scattered gravel lenses to at least 55 feet, which was the maximum depth of exploration.

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 property 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 Older Alluvium that underlies the subject area is mapped as having a probable maximum intensity of earthquake response of approximately VIII 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 C is a regional fault location map that shows the site's relationship to the identified faults in the region. Also in Appendix C is a summary table listing well-identified faults within a 35-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. It should be noted that although the distance to the surface trace of the Oak Ridge Fault is one mile, and the distance between the fault plane and the campus is approximately 0.9 miles, for the purposes of the seismic analyses presented below, the distance to the Oak Ridge Fault was assumed to be zero due to the location of the campus on the hanging wall.

5. For school projects, potential future seismic shaking must be evaluated using what is often referred to as the “general procedure”, which is also known as a probabilistic evaluation. The seismic design parameters presented herein 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 (34.2556° North Latitude and 119.1448° West Longitude, Soil Site Class D (for stiff soils), for Occupancy (Risk) Category III (which includes public school buildings). 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 which equates to a return rate of

2,475 years. 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 2019 California Building Code response spectrums. (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	1.924 g
Spectral Response Acceleration at 1 sec. – S_1	0.719g
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}	1.924 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}	1.283 g
One Second Spectral Response – S_{D1}	See CBC Section 11.4.8
Site-Modified Peak Ground Acceleration - PGA_M	0.936 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}	2.001 g
Site-Modified Spectral Response Acceleration at 1 sec. – S_{M1}	2.016 g
Design Earthquake Ground Motion	
Short Period Spectral Response – S_{DS}	1.334 g
One Second Spectral Response – S_{D1}	1.344 g
Site-Modified Peak Ground Acceleration - PGA_M	0.843 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 considered nil.

D. Liquefaction, Cyclic Softening, and Lateral Spreading

Earthquake-induced cyclic loading 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. Cyclic softening in clays during earthquakes has resulted in buildings experiencing foundation failure and ground surface deformation similar to that resultant from liquefaction. If liquefaction or cyclic softening occurs beneath sloping ground, a phenomenon known as lateral spreading can occur. Liquefaction and cyclic softening is typically limited to the upper 50 feet of the subsurface soils. There are a number of conditions that need to be satisfied for liquefaction or cyclic softening to occur. Of primary importance is that groundwater, perched or otherwise, usually must be within the upper 50 feet of soils.

The subject site is located within one of the Liquefaction Hazard Zones delineated by the State of California (CGS, 2003b).

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 (PI) 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 not encountered during the subsurface exploration performed for this study, which extended to a depth of 55 feet below the existing ground surface. A mapping of historic high groundwater levels in the subject area by the State shows the site to have a high groundwater level of about 25 feet below the surface (CGS, 2003a). Refer to map of historical high groundwater levels in Appendix A. Based on these data, high groundwater of 25 feet was assumed for the analysis.
2. Soils encountered throughout the explored depths of the subsurface were generally relatively clean sands.
3. Standard penetration tests conducted in the borings, and SPT blowcounts interpreted from CPT data, indicate that soils within the explored depth are in a generally dense to very dense state.

Calculations pertaining to liquefaction potential have considered the possibility that gravels encountered during sampling may have led to artificially high blow count measurements. Review of the pertinent logs, especially that of Boring B-1, indicates that gravels within various horizons were described as ”trace”, “little”, or “some”. Blow counts used in the analysis where gravel contents were considered “little” or “some” assumed that the lowest 6-inch blowcount among the three measured in that zone would be doubled to obtain a conservative blowcount for use in the analysis. For example, the measured 6-inch blowcounts in the SPT sample taken at 12.5 to 14 feet in Boring B-1 were

10/13/19. For the liquefaction analysis the blowcount for that zone was considered to be two times 10, i.e. 20 blows per one foot.

Based on the above, a cyclic mobility analysis was undertaken to analyze the liquefaction potentials of the various soil layers. The analysis was performed in general accordance with the methods proposed by NCEER (1997). In the analysis, the design earthquake was chosen to be a 7.2 moment magnitude event, and the site-modified peak ground acceleration of 0.94 g was utilized, as per the discussion in the “Seismicity and Seismic Design” section of this report.

The analysis for soils in the vicinity of Boring B-1 indicated that all layers had factors of safety that exceeded 1.3. The analysis for soils in the vicinity of sounding CPT-2 indicated that the soils between the depths of 36.5 and 37.5 feet and 41.5 and 42.5 feet had factors of safety less than 1.3 when groundwater is at the historical high level of 25 feet. Those zones with factors of safety greater than 1.3 are considered non-liquefiable (C.G.S., 2008, and SCEC, 1999).

The volumetric strain for the potentially liquefiable zones in sounding CPT-2 was estimated using a chart derived by Tokimatsu and Seed (1987) after reducing the $N_{1(60)}$ values derived by the analytical program by the calculated "FC Delta" value, then making adjustments for fines content as per Seed (1987) and SCEC (1999). Using this methodology, the volumetric strain when groundwater is at the historical high level of 25 feet was found to be 0.3 inch.

Although there will be no ground damage due to the depth of the shallowest liquefiable zone in CPT-2, there is a potential for a small amount of differential areal settlement suggested by the findings. As mentioned previously, the total liquefaction-related settlement could potentially range up to 0.3 inch near sounding CPT-2. According to SCEC (1999), up to about half of the total settlement could be realized as differential settlement. As a result, differential settlement could range up to about 0.15 inch at the ground surface.

Based on these calculations, liquefaction, cyclic softening, and lateral spreading do not appear to pose hazards that could adversely affect the proposed project.

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).

To analyze this phenomenon, the Tokimatsu and Seed procedure, as implemented by Pradel, was used. The site acceleration and earthquake magnitude used in the analysis were a modal magnitude of 7.2. The acceleration used in the analysis was two-thirds of the site-modified peak ground acceleration (0.94 g), i.e. 0.63 g. The blowcounts and stratigraphic data used were the same as those used in the liquefaction analysis (discussed above). The calculations for Boring B-1 and sounding CPT-2 indicate that seismically-induced settlement could range up to 0.4 inches, regardless of whether groundwater is at 25 feet or is not within the upper 51.5 feet of the soil profile. (Printouts of the analyses are attached.) This is a relatively insignificant amount of settlement; thus, it appears that the hazard posed by seismic-induced settlement of dry sands is low.

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 any of the tsunami inundation zones 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

Soils underlying the proposed bleachers area are generally Older Alluvial units consisting of silty sands over relatively clean sands with variable quantities of gravels. Soils encountered at approximate bearing depths are characterized by moderate to high blow counts and in-place densities, and moderate to low compressibilities. Testing indicates that anticipated bearing soils lie in the "very low" expansion range because the expansion index is 0. [A locally adopted version of this classification of soil expansion, i.e. Table 1809.7, is included in Appendix B of this report.] It appears that soils can be cut by normal grading equipment.

Groundwater was not encountered to a depth of 55 feet. Mapping of historic high groundwater levels in the subject area shows the site to have a high groundwater level of about 25 feet below the surface (CGS, 2003a).

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 (130 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 (5,000 ohms-cm) indicate that they are "moderately corrosive" to ferrous metal (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.

A. Grading

1. Pre-Grading Considerations

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 structure 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. Shrinkage from removal of the existing foundation system is not included in these figures.

d. 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 subgrade elevation in the final pad.

e. 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.

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 all vegetation, trees, large roots, debris, other organic material and non-complying fill. Organics and debris should be stockpiled away from areas to be graded, and ultimately removed from the site to prevent their inclusion in fills. Voids created by removal of such material should be properly backfilled and compacted. No compacted fill should be placed unless the underlying soil has been observed by the Geotechnical Engineer.

c. If conventional pad footings are to be used to support the bleachers, overexcavation and recompaction of soils under footings will be necessary to decrease the potential for differential settlement and provide more uniform bearing conditions due to the presence of variable density soils at the bearing depth. Soils should be overexcavated to a depth of 2.5 feet below the bottoms of footings and to a distance of 5 feet on each side of the footings. The resulting surfaces should then be scarified an additional 6 inches, moisture conditioned, and recompacted. The intent of these recommendations is to have a minimum of 3 feet of compacted soil below the bottoms of all footings.

d. If pier footings are to be used, the overexcavation and recompaction described above will not be necessary.

e. Areas outside of the bleachers bearing zone area to receive fill, exterior slabs-on-grade, sidewalks, or paving should be overexcavated to a depth of 1.5 feet. The resulting surface should then be scarified an additional 6 inches, moisture conditioned and recompacted.

f. The bottom of all excavations should be observed by a representative of this firm prior to processing or placing fill.

g. 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.

h. Fill and backfill placed at or slightly above optimum moisture 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.

i. Import soils used to raise site grade should be equal to, or better than, on-site soils in strength, expansion, and compressibility characteristics. Import soil can be evaluated, but will not be prequalified by the Geotechnical Engineer. Final comments on the characteristics of the import will be given after the material is at the project site.

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

B. Structural Design

1. Conventional Spread Foundations
   a. Conventional continuous footings and/or isolated pad footings may be used to support the bleachers.
   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. Isolated pad footings may be designed based on an allowable bearing value of 2.500 psf. This value is based on a factor of safety of at least 3.
   d. Allowable bearing values are net (weight of footing and soil surcharge may be neglected) and are applicable for dead plus reasonable live loads.
   e. A one-third increase is permitted for use with the alternative load combinations given in Section 1605.3.2 of the 2019 CBC.
   f. Lateral loads may be resisted by soil friction on foundations and by passive resistance of the soils acting on the sides of foundations. Lateral capacity is based on the assumption that any required backfill adjacent to foundations and grade beams is properly compacted.
   g. Actual footing designs should be provided by the Structural Engineer, but the dimensions and reinforcement he recommends should not be less than the criteria set forth in Table 1809.7 for the “very low” expansion range.
   h. Soils should be lightly moistened prior to placing concrete. Testing of premoistening is not required.

2. Drilled Pier Foundations
   a. As a minimum, the new piers should be at least twenty-four inches (24”) in diameter and embedded a minimum of 10 feet below the existing ground surface. However, the Structural Engineer may require greater depths of penetration to achieve the design bearing and lateral capacities. The Geotechnical Engineer should be consulted during pier installation to determine compliance with the geotechnical recommendations.
   b. For vertical (axial compression) and uplift capacity, the attached pile capacity graphs may be used. Drilled pier diameters of 2, 2.5, and 3 feet were analyzed, and the results are presented on the attached charts. Side resistance is not allowed to increase beyond a depth equal to 20 pile diameters. Upward

resistance is taken as two-thirds of the downward resistance. The downward and upward capacity graphs for drilled piers are presented in Appendix E.

c. The load capacities shown on the attached charts are based upon skin friction with no end bearing. Therefore, it is not necessary to thoroughly clean the bottoms of the pier excavations. However, loose soils, slough, or debris should be removed. These allowable capacities include a safety factor of 2.0.

d. Reduction in axial capacity due to group effects should be considered for piers spaced at 3 diameters on-center or closer.

e. All piers should be tied together laterally (in both directions) at the top with grade beams. The size, spacing, and reinforcing of grade beams should be determined by the Structural Engineer.

f. The compressive and tensile strength of new pier designs should be checked to verify the structural capacity of the piers. Reinforcement of piers should be specified by the Structural Engineer. The specific method of pier installation will affect the performance of the piers. Earth Systems recommends a meeting with the design team and Contractor to verify that the specific method of pier installation can provide the anticipated load supporting capacity.

g. Lateral (horizontal) loads may be resisted by passive resistance of soil against the piers. An equivalent fluid weight (EFW) of 350 psf per foot of penetration in firm, native soil above the groundwater table may be used for lateral load design. This resisting pressure is an ultimate value. The maximum passive pressure used for design should not exceed 5,000 psf.

h. For piers spaced at least 3 diameters apart, an effective width of three times the actual pier diameter may be used for passive pressure calculations.

. i. Pier excavations are unlikely to encounter groundwater; however, due to the presence of relatively “clean” sands, temporary casing may be necessary to minimize bore-hole caving during pier construction. Use of special drilling mud or other methods to keep boreholes open during construction may be acceptable upon review by the Geotechnical Engineer.

j. Pier drilling operations should be observed by the Geotechnical Engineer, or his representative.

3. Frictional and Lateral Coefficients

a. Resistance to lateral loading may be provided by friction acting on the bases of foundations. A coefficient of friction of 0.62 may be applied to dead load forces. This value does not include a factor of safety.

b. 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.

4. Settlement Considerations

a. Maximum settlements of about an inch are anticipated for foundations designed as recommended.

b. Differential settlement between adjacent load bearing members should be less than one-half the total settlement.

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 CPT soundings and borings drilled on the site. The nature and extent of variations between and beyond the soundings and borings 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.

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APPENDIX A

Vicinity Map

Regional Fault Map

Regional Geologic Map

Seismic Hazard Zones Map

Historical High Groundwater Map

Field Study

Geologic Map

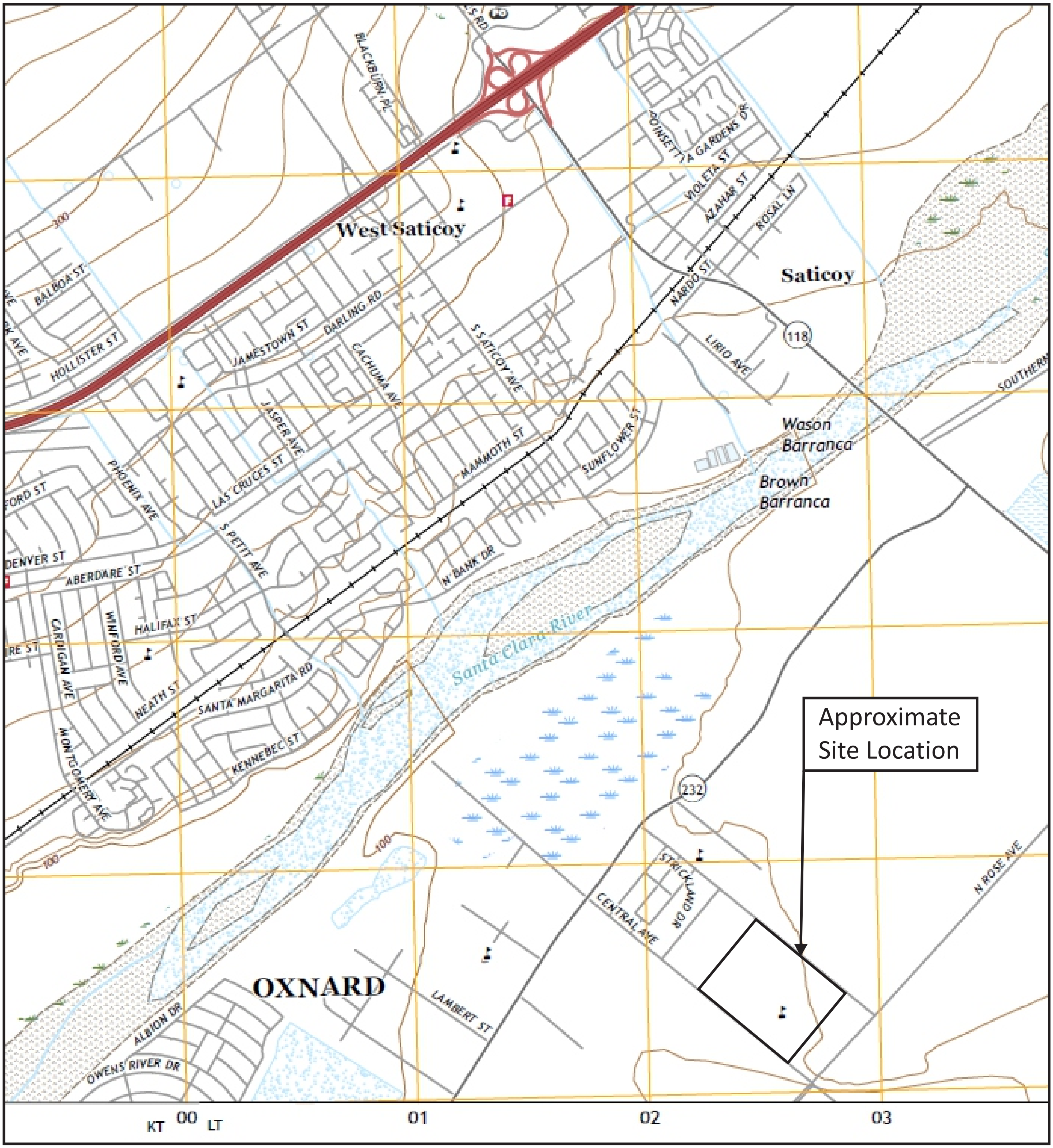
Geologic Cross-Section

Logs of Borings

Logs and Interpretations of CPT Soundings

Boring Log Symbols

Unified Soil Classification System



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

Approximate Scale: 1" = 2,000’

0 2,000’ 4,000’

N

VICINITY MAP

Rio Mesa High School Home Bleachers
Oxnard, California

Earth Systems

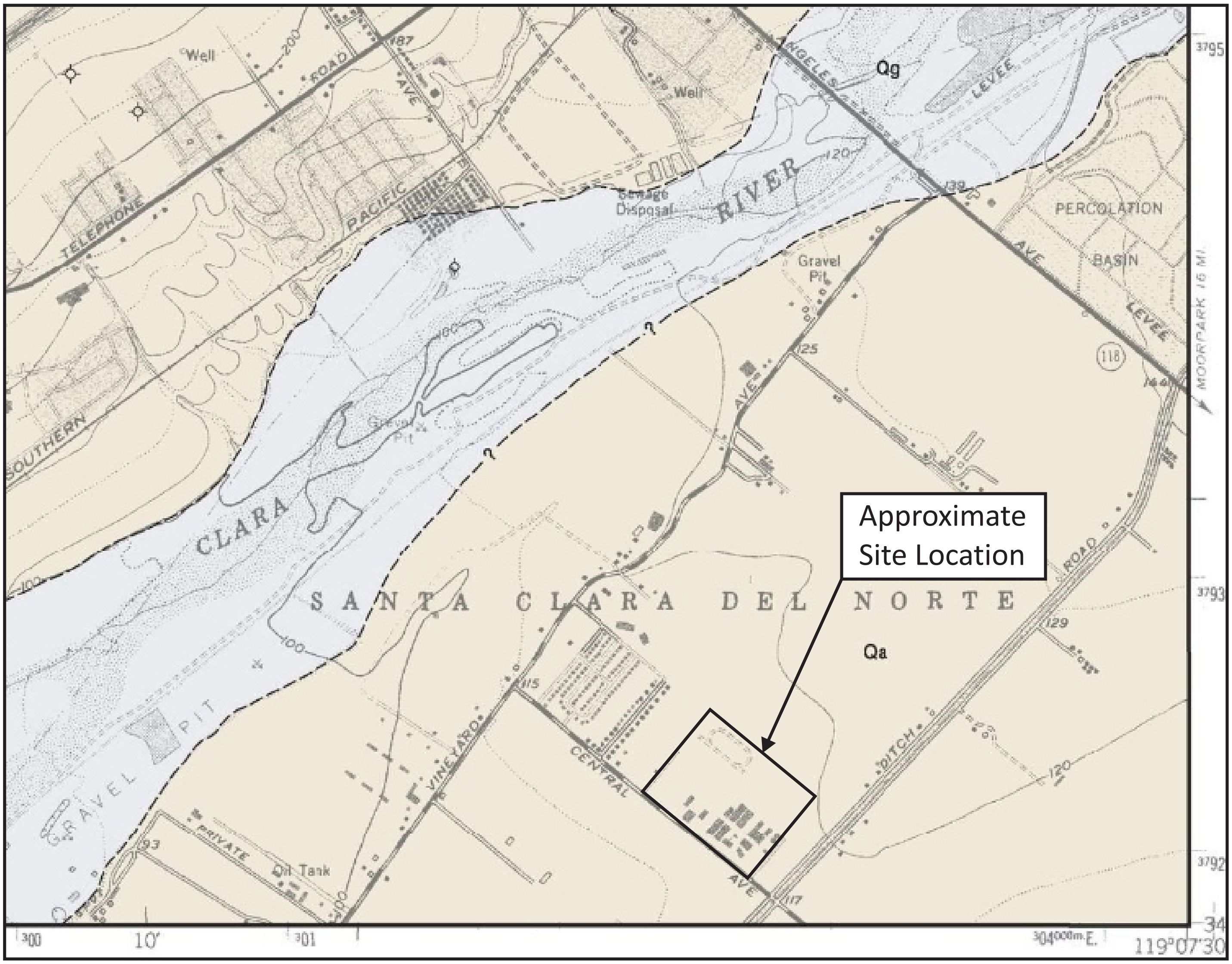
February 2020	303280-002

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

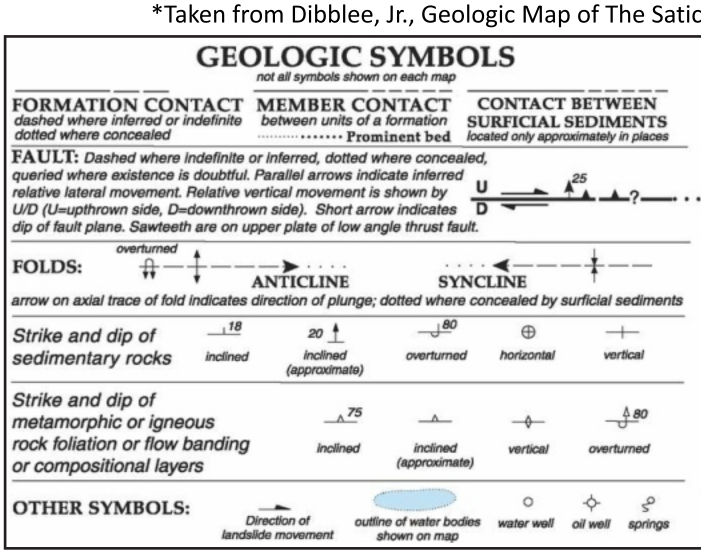
Approximate Scale:
1 Inch = 2 Mile

N

REGIONAL FAULT MAP	
Rio Mesa High School Home Bleachers Oxnard, Ventura County, California	
Earth Systems	
February 2020	303280-002



*Taken from Dibblee, Jr., Geologic Map of The Saticoy Quadrangle, Ventura County, California, 1992, DF-42.



LEGEND

Qg	Qa

SURFICIAL SEDIMENTS

Unconsolidated alluvial deposits, generally undissected

Qg *Gravel, sand and silt of major stream channels*

Qa *Alluvium: silt, sand and gravel of valley and floodplain areas*

Approximate Scale: 1" = 2,000'

0 2,000' 4,000'

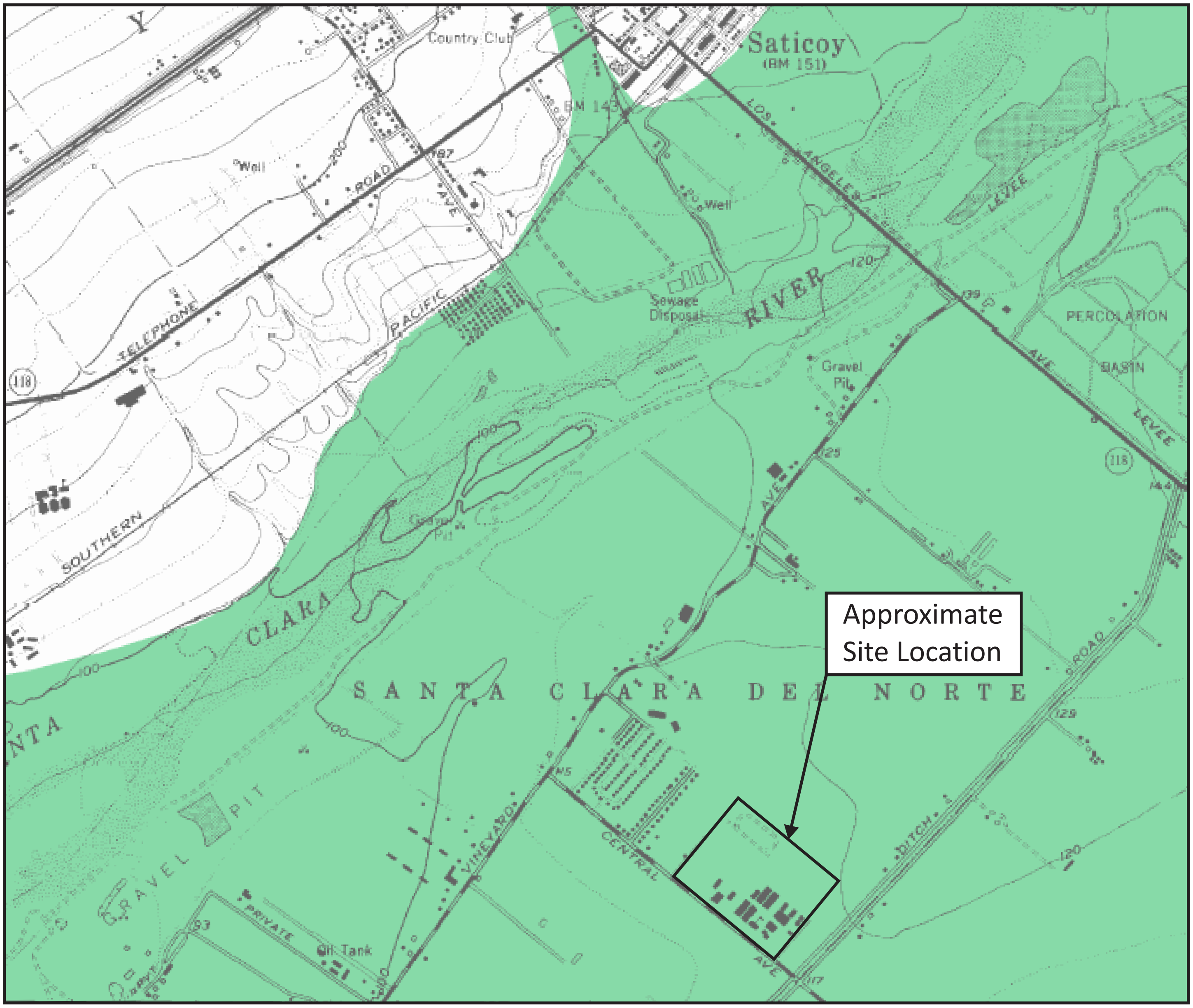
N

REGIONAL GEOLOGIC MAP

Rio Mesa High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303280-002



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.

Earthquake-Induced Landslides

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

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.

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)

SATICOY QUADRANGLE

OFFICIAL MAP

Released: February 14, 2003

N

Approximate Scale: 1" = 2,000'

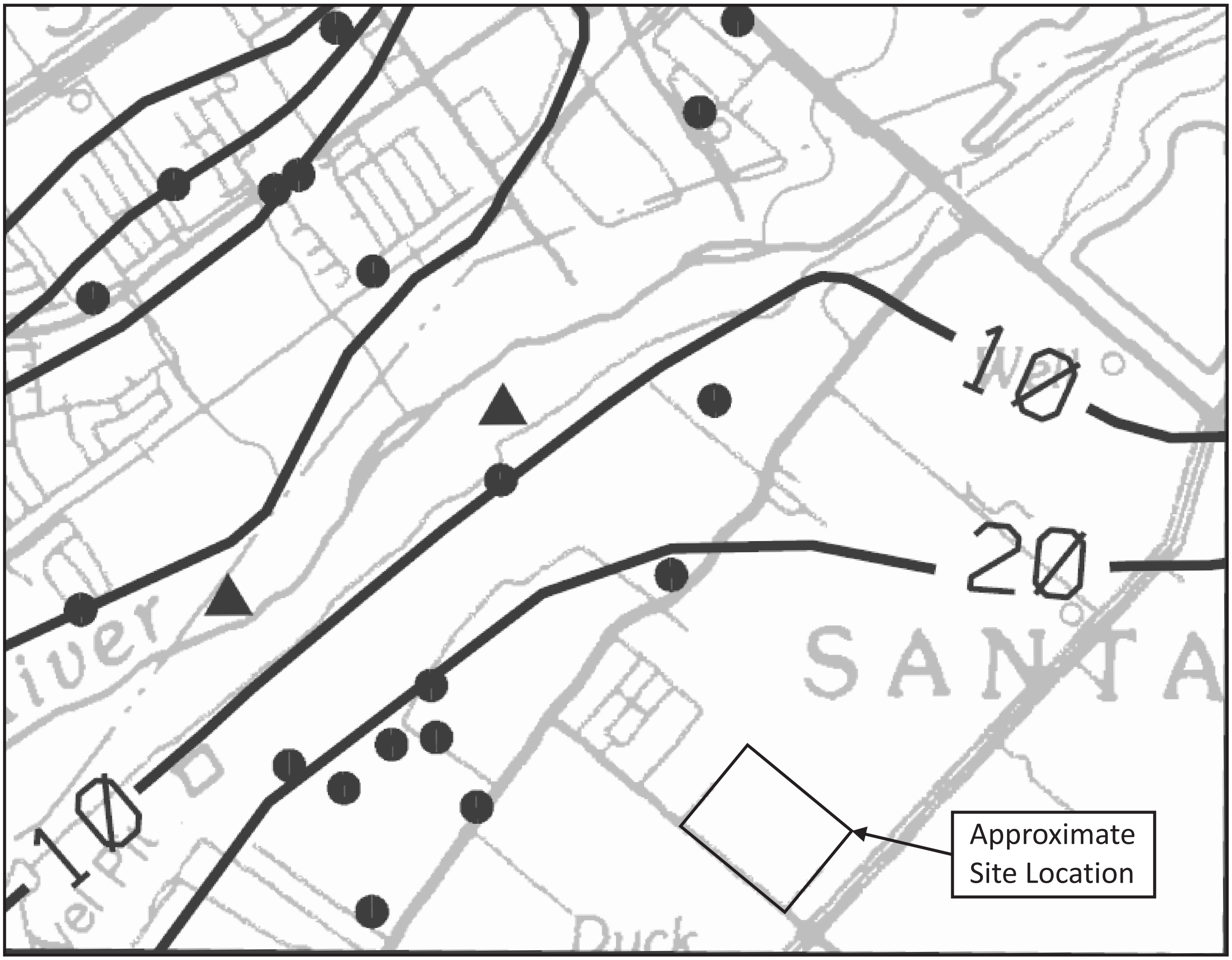
0 2,000' 4,000'

SEISMIC HAZARD ZONES MAP

Rio Mesa High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303280-002



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

Alluviated Valley Boundary

Borehole Site

20 Historically shallowest ground–water depth contours (in feet)

>40 Historically shallowest ground–water depth greater than 40 feet over a broad area

Approximate location of sand boils and lurch cracks observed following the Point Mugu Earthquake of February 21, 1973.

Approximate Scale: 1" = 2,000'

0 2,000' 4,000'

N

HISTORICAL HIGH GROUNDWATER MAP

Rio Mesa High School Home Bleachers
Oxnard, California

Earth Systems

February 2020	303280-002

FIELD STUDY

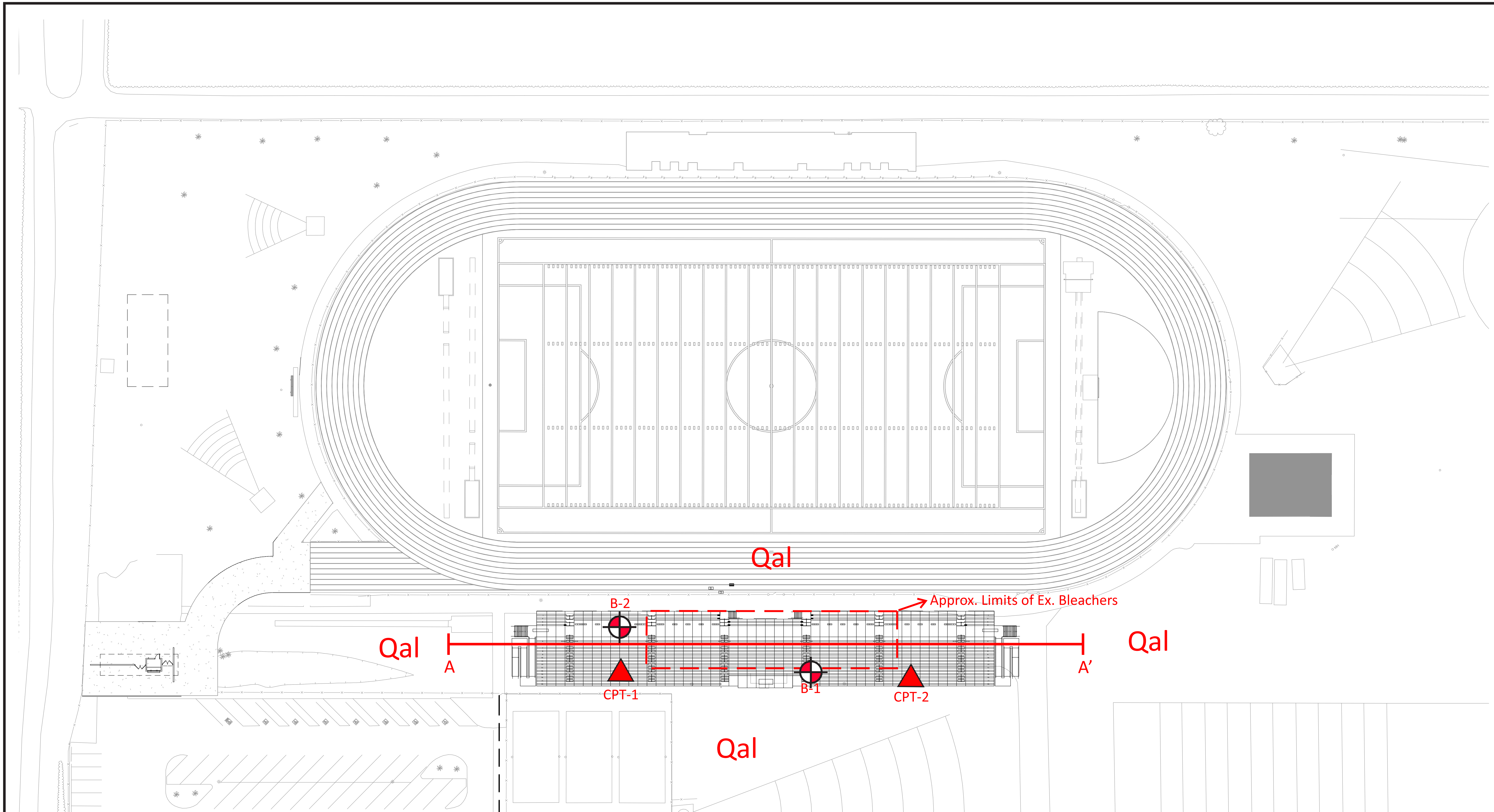
A. On December 2, 2019, two borings were drilled to observe the soil profile and to obtain samples for laboratory analysis. The first boring (B-1) was advanced to a maximum depth of 51.5 feet below the existing ground surface and the second (B-2) was advanced to 21.5 feet. The borings were drilled using an 8-inch diameter hollow stem auger powered by a SIMCO truck mounted drilling rig.

B. On January 14, 2020, two Cone Penetrometer Test (CPT) soundings to obtain additional information pertaining to the soil profile. One sounding (CPT-1) was advanced to a depth of approximately 31 feet, and the second (CPT-2) was advanced to a depth of about 55 feet. The 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.

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 were gathered from cuttings from the upper 5 feet of Boring B-1.

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 CPT 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

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

A A' : Line of Cross-Section

B-2 : Exploratory Boring Locations

Approximate Scale: 1" = 60'

0 60' 120'

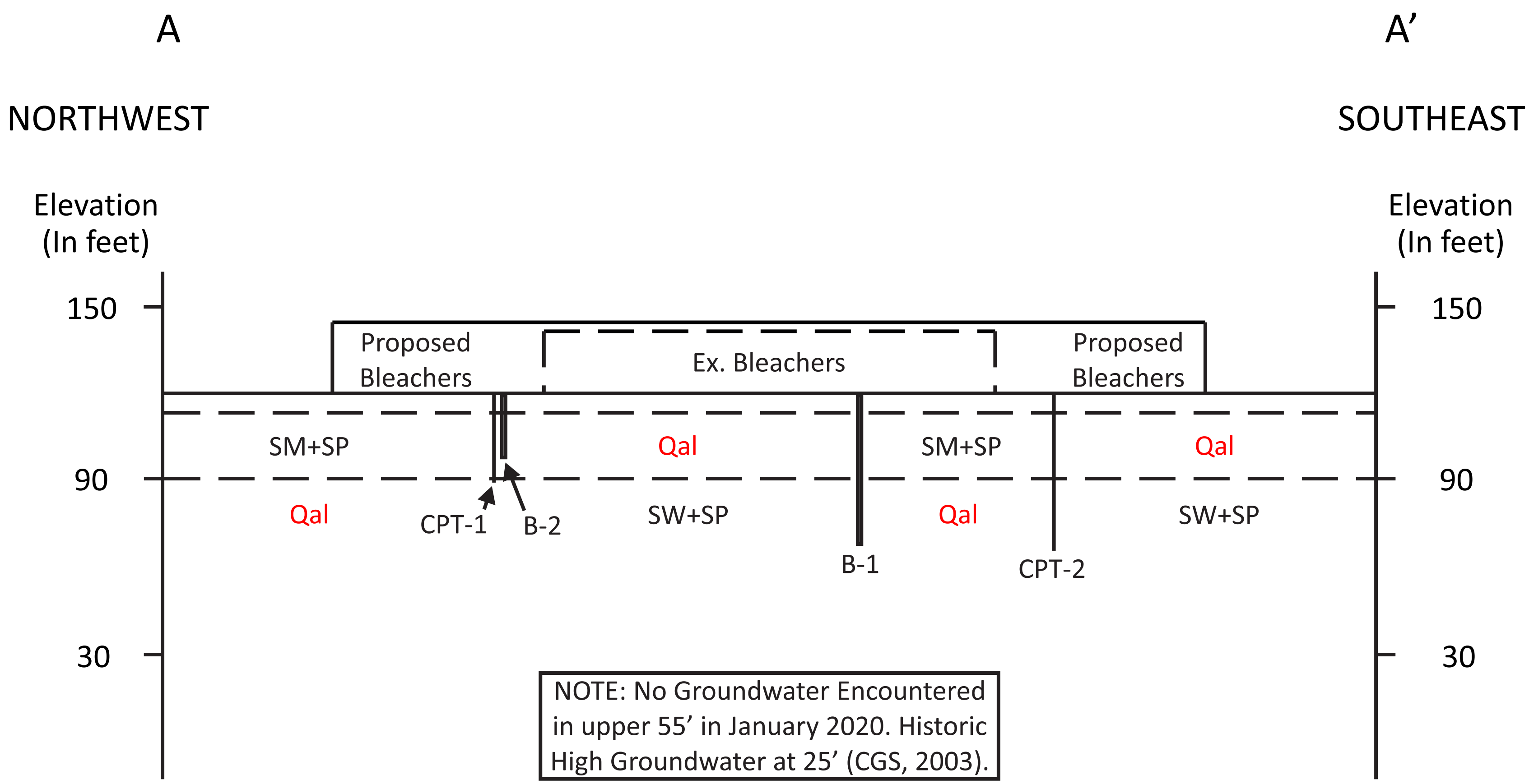
N

GEOLOGIC MAP

Rio Mesa High School Home Bleachers
Ventura County, California

Earth Systems

February 2020 | 303280-002



SM+SP : Silty Sand + Poorly Sorted Sand
SW+SP : Well Sorted Sand + Poorly Sorted Sand
Qal : Alluvial Deposits

Approximate Scale: 1" = 60’

0 60’ 120’

GEOLOGIC CROSS-SECTION A-A’

Rio Mesa High School Home Bleachers
Ventura County, California

Earth Systems

February 2020	303280-002

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

BORING NO: B-1	DRILLING DATE: December 2, 2019
PROJECT NAME: Rio Mesa High School Home Bleachers	DRILL RIG: SIMCO
PROJECT NUMBER: 303280-002	DRILLING METHOD: 8-Inch Hollow-Stem Auger
BORING LOCATION: Per Plan	LOGGED BY: A. Luna

Vertical Depth	Sample Type	PENETRATION RESISTANCE (BLOWS/6")	USCS CLASS	UNIT DRY WT. (pcf)	MOISTURE CONTENT (%)	DESCRIPTION OF UNITS
0	Bulk		SM			**ALLUVIUM:** Brown Silty fine Sand, little medium Sand, trace coarse Sand, medium dense, damp
	Mod. Calif.	22/12/12	SM	120.3	8.2	
5	Mod. Calif.	5/11/18	SW	103.4	8.1	**ALLUVIUM:** Light Brown fine to medium Sand, little Silt, medium dense, damp
	Mod. Calif.	18/16/23	SW	102.3	3.5	**ALLUVIUM:** Brown fine to coarse Sand, little fine to coarse Gravel, dense, dry to damp
10	Mod. Calif.	19/32/36	SW	125.4	6.6	**ALLUVIUM:** Brown Gravelly Sand, trace Silt, very dense, dry to damp
	SPT	10/13/19	SW			**ALLUVIUM:** Brown fine to coarse Sand, some Gravel, dense to very dense, dry to damp
15	Mod. Calif.	21/30/40	SW		4.5	
	SPT	14/28/40				
20	Mod. Calif.	38/50-6"				
	SPT	10/15/18	SW			**ALLUVIUM:** Brown fine to medium Sand, trace coarse Sand, trace Silt nodules, trace fine Gravel, dense, damp
25	SPT	12/15/17	SW			**ALLUVIUM:** Brown fine to medium Sand, little coarse Sand, dense, dry to damp
	SPT	29/25/30	SW			**ALLUVIUM:** Brown fine to medium Sand, little coarse Sand, trace fine to coarse Gravel, very dense, dry to damp
30	SPT	18/28/27				
	SPT	18/26/28				
35	SPT	19/23/24	SW			**ALLUVIUM:** Brown fine to coarse Sand, little fine to coarse Gravel, dense, dry to damp
	SPT	14/30/24	SP			**ALLUVIUM:** Light Brown fine Sand, little medium Sand, trace coarse Sand, little fine Gravel, very dense, dry to damp

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 B-1 (Continued)
PROJECT NAME: Rio Mesa High School Home Bleachers
PROJECT NUMBER: 303277-002
BORING LOCATION: Per Plan

DRILLING DATE: December 2, 2019
DRILL RIG: SIMCO
DRILLING METHOD: 8-Inch Hollow-Stem Auger
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		X		15/30/34		SW			**ALLUVIUM:** Brown fine to coarse Sand, little fine to coarse Gravel, very dense dry to damp
		X		10/20/32		SP			**ALLUVIUM:** Brown fine Sand, trace medium Sand, very dense, dry to damp
45		X		12/23/32					
		X		10/10/32		SW			**ALLUVIUM:** Brown fine to medium Sand, trace coarse Sand, trace fine Gravel, dense to very dense, dry to damp
50		X		14/39/30					
									Total Depth: 51.5 feet
									No Groundwater Encountered
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-2
PROJECT NAME: Rio Mesa High School Home Bleachers
PROJECT NUMBER: 303280-002
BORING LOCATION: Per Plan

DRILLING DATE: December 2, 2019
DRILL RIG: SIMCO
DRILLING METHOD: 8-Inch Hollow-Stem Auger
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						SM			**ALLUVIUM:** Brown Silty fine to medium Sand, little coarse Sand, trace fine to coarse Gravel, very dense, dry to damp
			■	21/24/29			119.0	11.9	
5			■	7/18/21		SW	106.6	7.5	**ALLUVIUM:** Light Brown fine to medium Sand, little coarse Sand, trace fine to coarse Gravel, dense, dry to damp
			■	13/15/17		SW	107.4	7.0	**ALLUVIUM:** Brown fine to coarse Sand, some fine to coarse Gravel, dense, dry to damp
10			■	8/50-5"		SW	109.8	5.8	**ALLUVIUM:** Brown fine to coarse Sand, some fine to coarse Gravel, very dense, dry to damp
15			■	18/40/41			115.0	9.1	
20			■	31/50-2"				4.8	
									Total Depth: 21.5 feet
									No Groundwater Encountered
25									
30									
35									

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

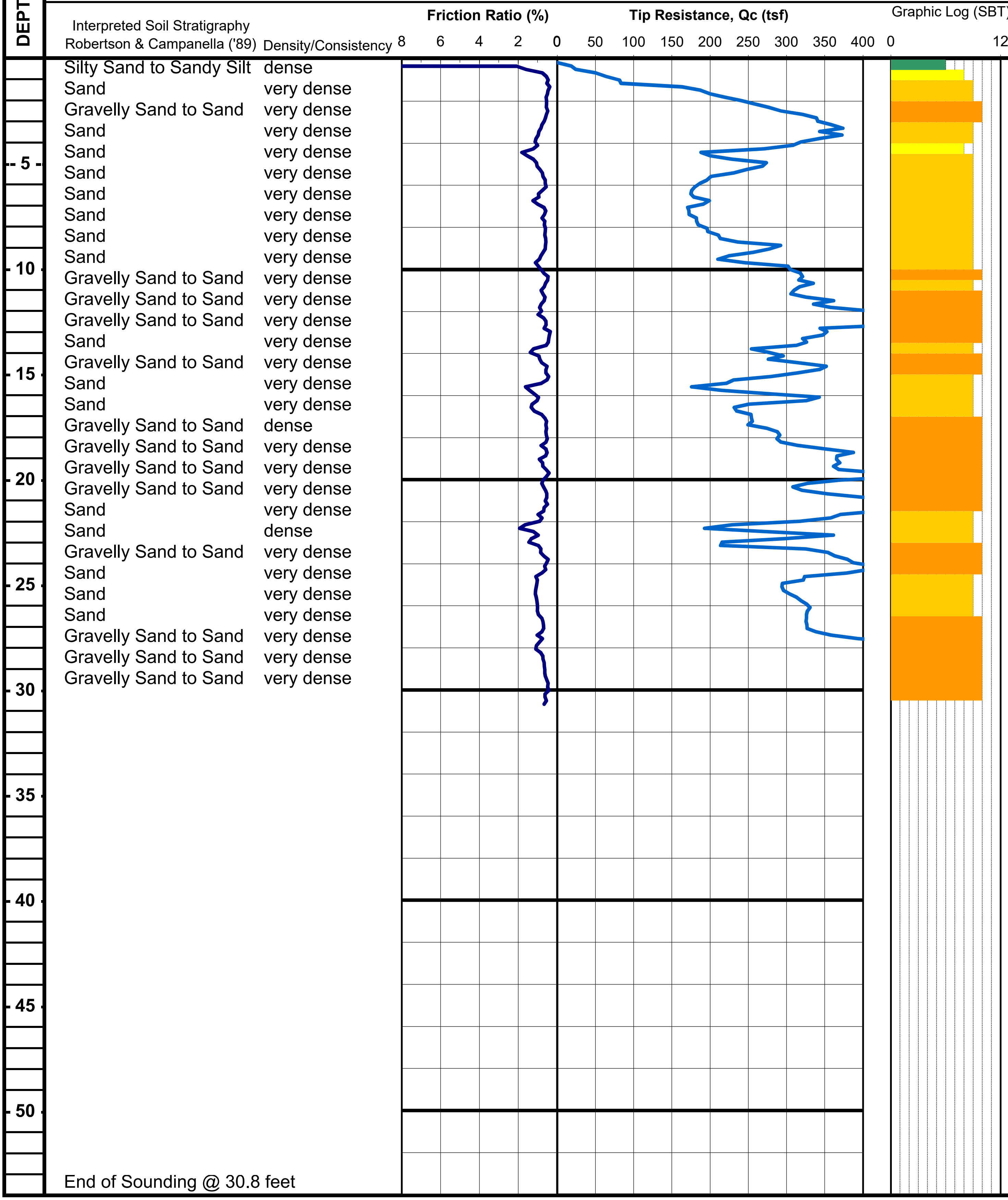
CPT No: CPT-1

Project Name: Rio Mesa HS Home Bleachers
Project No.: 303280-002
Location: See Site Exploration Plan

CPT Vendor: **Kehoe Testing and Engineering**
Truck Mounted Electric
Cone with 23-ton reaction
Date: 1/14/2020

DEPTH (FEET)

Interpreted Soil Stratigraphy Robertson & Campanella ('89)	Density/Consistency
Silty Sand to Sandy Silt	dense
Sand	very dense
Gravelly Sand to Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense
Sand	very dense
Gravelly Sand to Sand	very dense
Sand	very dense
Sand	very dense
Gravelly Sand to Sand	dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense
Sand	very dense
Sand	dense
Gravelly Sand to Sand	very dense
Sand	very dense
Sand	very dense
Sand	very dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense
Gravelly Sand to Sand	very dense



End of Sounding @ 30.8 feet

Earth Systems

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Rio Mesa HS Home Bleachers Project No: 303280-002 Date: 01/14/20

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

Est. GWT (feet): **52.0** Dr correlation: 0 Baldi Qc/N: 1 Robertson Phi Correlation: 4 SPT N

Nk: 17

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.)	Su (tsf)	OCR
0.15	0.5	31.24	1.48	Sandy Silt to Clayey Silt	ML	medium dense	110	2.5	12	0.014	0.014	1.48	0.68	1.70	50.2	2.25	90.2	21	18	48	34		
0.30	1.0	76.33	0.51	Sand to Silty Sand	SP/SM	dense	100	4.0	19	0.040	0.040	0.51	0.51	1.70	122.6	1.66	124.1	32	25	85	37		
0.46	1.5	183.68	0.44	Sand	SP	very dense	100	5.0	37	0.065	0.065	0.44	0.50	1.70	295.1	1.32	295.1	62	59	100	43		
0.61	2.0	239.22	0.54	Sand	SP	very dense	100	5.0	48	0.090	0.090	0.54	0.50	1.70	384.4	1.30	384.4	81	77	100	45		
0.76	2.5	296.72	0.53	Gravelly Sand to Sand	SW	very dense	110	6.0	49	0.116	0.116	0.53	0.50	1.70	476.8	1.23	476.8	84	95	100	46		
0.91	3.0	346.07	0.68	Gravelly Sand to Sand	SW	very dense	110	6.0	58	0.144	0.144	0.68	0.50	1.70	556.1	1.28	556.1	98	111	100	47		
1.07	3.5	363.23	0.91	Sand	SP	very dense	100	5.0	73	0.170	0.170	0.91	0.50	1.70	583.6	1.37	583.6	123	117	100	49		
1.22	4.0	323.18	1.07	Sand	SP	very dense	100	5.0	65	0.195	0.195	1.07	0.50	1.70	519.3	1.46	519.3	110	104	100	48		
1.37	4.5	219.81	1.52	Sand to Silty Sand	SP/SM	very dense	100	4.0	55	0.220	0.220	1.53	0.51	1.70	353.2	1.68	361.6	93	72	100	47		
1.52	5.0	256.57	1.10	Sand	SP	very dense	100	5.0	51	0.245	0.245	1.10	0.50	1.70	412.3	1.52	412.3	87	82	100	46		
1.68	5.5	218.83	0.74	Sand	SP	very dense	100	5.0	44	0.270	0.270	0.74	0.50	1.70	351.6	1.43	351.6	74	70	100	45		
1.83	6.0	180.90	0.63	Sand	SP	very dense	100	5.0	36	0.295	0.295	0.63	0.50	1.70	290.7	1.43	290.7	62	58	100	43		
1.98	6.5	184.25	1.04	Sand	SP	very dense	100	5.0	37	0.320	0.320	1.04	0.50	1.70	296.0	1.59	296.0	63	59	100	43		
2.13	7.0	178.00	0.75	Sand	SP	very dense	100	5.0	36	0.345	0.345	0.75	0.50	1.70	286.0	1.49	286.0	61	57	100	42		
2.29	7.5	178.98	0.68	Sand	SP	very dense	100	5.0	36	0.370	0.370	0.68	0.50	1.69	286.1	1.46	286.1	59	57	100	42		
2.44	8.0	192.50	0.61	Sand	SP	very dense	100	5.0	39	0.395	0.395	0.61	0.50	1.64	297.8	1.42	297.8	61	60	100	43		
2.59	8.5	220.07	0.59	Sand	SP	very dense	100	5.0	44	0.420	0.420	0.59	0.50	1.59	330.1	1.38	330.1	68	66	100	44		
2.74	9.0	275.37	0.64	Sand	SP	very dense	100	5.0	55	0.445	0.445	0.64	0.50	1.54	401.3	1.34	401.3	83	80	100	46		
2.90	9.5	226.34	0.95	Sand	SP	very dense	100	5.0	45	0.470	0.470	0.95	0.50	1.50	321.0	1.54	321.0	66	64	100	43		
3.05	10.0	308.31	0.82	Sand	SP	very dense	100	5.0	62	0.495	0.495	0.82	0.50	1.46	426.0	1.41	426.0	88	85	100	46		
3.20	10.5	323.94	0.51	Gravelly Sand to Sand	SW	very dense	110	6.0	54	0.521	0.521	0.51	0.50	1.42	436.2	1.25	436.2	75	87	100	45		
3.35	11.0	310.77	0.73	Sand	SP	very dense	100	5.0	62	0.548	0.548	0.74	0.50	1.39	408.3	1.39	408.3	84	82	100	46		
3.51	11.5	340.66	0.70	Gravelly Sand to Sand	SW	very dense	110	6.0	57	0.574	0.574	0.70	0.50	1.36	437.2	1.35	437.2	75	87	100	45		
3.66	12.0	412.17	0.89	Gravelly Sand to Sand	SW	very dense	110	6.0	69	0.601	0.601	0.89	0.50	1.33	516.8	1.39	516.8	89	103	100	46		
3.81	12.5	439.48	0.61	Gravelly Sand to Sand	SW	very dense	110	6.0	73	0.629	0.629	0.61	0.50	1.30	538.8	1.25	538.8	92	108	100	47		
3.96	13.0	347.98	0.46	Gravelly Sand to Sand	SW	very dense	110	6.0	58	0.656	0.656	0.46	0.50	1.27	417.6	1.23	417.6	72	84	100	44		
4.11	13.5	319.76	0.48	Gravelly Sand to Sand	SW	very dense	110	6.0	53	0.684	0.684	0.48	0.50	1.24	376.0	1.27	376.0	64	75	100	43		
4.27	14.0	275.39	1.17	Sand	SP	very dense	100	5.0	55	0.710	0.710	1.18	0.50	1.22	317.7	1.61	317.7	65	64	100	43		
4.42	14.5	314.21	0.73	Gravelly Sand to Sand	SW	very dense	110	6.0	52	0.736	0.736	0.73	0.50	1.20	356.0	1.42	356.0	61	71	100	43		
4.57	15.0	312.02	0.53	Gravelly Sand to Sand	SW	very dense	110	6.0	52	0.764	0.764	0.53	0.50	1.18	347.1	1.32	347.1	60	69	100	42		
4.72	15.5	208.88	0.98	Sand	SP	dense	100	5.0	42	0.790	0.790	0.99	0.50	1.16	228.6	1.65	228.7	47	46	100	40		
4.88	16.0	290.40	1.14	Sand	SP	very dense	100	5.0	58	0.815	0.815	1.14	0.50	1.14	312.7	1.61	312.7	64	63	100	43		
5.03	16.5	238.97	1.26	Sand	SP	very dense	100	5.0	48	0.840	0.840	1.27	0.52	1.13	254.5	1.70	263.8	52	53	100	41		
5.18	17.0	254.19	0.65	Sand	SP	very dense	100	5.0	51	0.865	0.865	0.65	0.50	1.11	265.7	1.47	265.7	55	53	100	41		
5.33	17.5	270.29	0.56	Gravelly Sand to Sand	SW	dense	110	6.0	45	0.891	0.891	0.56	0.50	1.09	278.4	1.41	278.4	48	56	100	40		
5.49	18.0	290.32	0.54	Gravelly Sand to Sand	SW	very dense	110	6.0	48	0.919	0.919	0.54	0.50	1.07	294.5	1.38	294.5	50	59	100	41		
5.64	18.5	350.74	0.63	Gravelly Sand to Sand	SW	very dense	110	6.0	58	0.946	0.946	0.63	0.50	1.06	350.5	1.38	350.5	60	70	100	42		
5.79	19.0	366.90	0.75	Gravelly Sand to Sand	SW	very dense	110	6.0	61	0.974	0.974	0.75	0.50	1.04	361.5	1.43	361.5	62	72	100	43		
5.94	19.5	384.67	0.57	Gravelly Sand to Sand	SW	very dense	110	6.0	64	1.001	1.001	0.57	0.50	1.03	373.7	1.33	373.7	64	75	100	43		
6.10	20.0	383.89	0.68	Gravelly Sand to Sand	SW	very dense	110	6.0	64	1.029	1.029	0.68	0.50	1.01	368.0	1.39	368.0	63	74	100	43		
6.25	20.5	327.75	0.60	Gravelly Sand to Sand	SW	very dense	110	6.0	55	1.056	1.056	0.61	0.50	1.00	310.0	1.40	310.0	53	62	100	41		
6.40	21.0	443.19	0.54	Gravelly Sand to Sand	SW	very dense	110	6.0	74	1.084	1.084	0.54	0.50	0.99	413.9	1.28	413.9	71	83	100	44		
6.55	21.5	409.18	0.77	Gravelly Sand to Sand	SW	very dense	110	6.0	68	1.111	1.111	0.78	0.50	0.98	377.4	1.42	377.4	65	75	100	43		
6.71	22.0	300.81	1.10	Sand	SP	very dense	100	5.0	60	1.138	1.138	1.11	0.50	0.96	274.2	1.63	274.2	56	55	100	42		
6.86	22.5	275.73	1.37	Sand	SP	very dense	100	5.0	55	1.163	1.163	1.37	0.53	0.95	248.0	1.73	262.7	51	53	100	41		
7.01	23.0	242.36	1.25	Sand	SP	dense	100	5.0	48	1.188	1.188	1.26	0.53	0.94	215.5	1.74	229.6	44	46	100	39		
7.16	23.5	347.43	0.78	Gravelly Sand to Sand	SW	very dense	110	6.0	58	1.214	1.214	0.78	0.50	0.93	306.6	1.49	306.6	53	61	100	41		
7.32	24.0	394.45	0.54	Gravelly Sand to Sand	SW	very dense	110	6.0	66	1.241	1.241	0.54	0.50	0.92	344.2	1.34	344.2	59	69	100	42		
7.47	24.5	369.47	0.82	Gravelly Sand to Sand	SW	very dense	110	6.0	62	1.269	1.269	0.82	0.50	0.91	318.9	1.49	318.9	55	64	100	41		
7.62	25.0	303.42	1.04	Sand	SP	very dense	100	5.0	61	1.295	1.295	1.04	0.50	0.90	259.2	1.63	259.2	53	52	100	41		
7.77	25.5	304.41	1.09	Sand	SP	very dense	100	5.0	61	1.320	1.320	1.10	0.50	0.89	257.5	1.65	257.6	53	52	100	41		
7.92	26.0	325.34	1.01	Sand	SP	very dense	100	5.0	65	1.345	1.345	1.02	0.50	0.89	272.7	1.61	272.7	56	55	100	42		
8.08	26.5	326.17	0.87	Sand	SP	very dense	100	5.0	65	1.370	1.370	0.87	0.50	0.88	270.9	1.56	270.9	56	54	100	42		
8.23	27.0	330.64	0.72	Gravelly Sand to Sand	SW	dense	110	6.0	55	1.396	1.396	0.72	0.50	0.87	272.0	1.49	272.0	47	54	100	40		
8.38	27.5	404.32	0.89	Gravelly Sand to Sand	SW	very dense	110	6.0	67	1.424	1.424	0.89	0.50	0.86	329.4	1.51	329.4	56	66	100	42		
8.53	28.0	445.80	1.00	Gravelly Sand to Sand	SW	very dense	110	6.0	74	1.451	1.451	1.00	0.50	0.85	359.8	1.52	359.8	62	72	100	43		
8.69	28.5	473.44	0.70	Gravelly Sand to Sand	SW	very dense	110	6.0	79	1.479	1.479	0.70	0.50	0.85	378.5	1.39	378.5	65	76	100	43		
8.84	29.0	482.25	0.63	Gravelly Sand to Sand	SW	very dense	110	6.0	80	1.506	1.506	0.64	0.50	0.84	382.0	1.36	382.0	65	76	100	43		
8.99	29.5	495.67	0.52	Gravelly Sand to Sand	SW	very dense	110	6.0	83	1.534	1.534	0.53	0.50	0.83	389.1	1.29	389.1	67	78	100	43		
9.14	30.0	616.76	0.51	Gravelly Sand to Sand	SW	very dense	110	6.0	103	1.561	1.561	0.51	0.50	0.82	479.9	1.22	479.9	82	96	100	46		
9.30	30.5	660.58	0.61	Gravelly Sand to Sand	SW	very dense	110	6.0	110	1.589	1.589	0.61	0.50	0.82	509.5	1.26	509.5	87	102	100	46		

CPT No: CPT-2

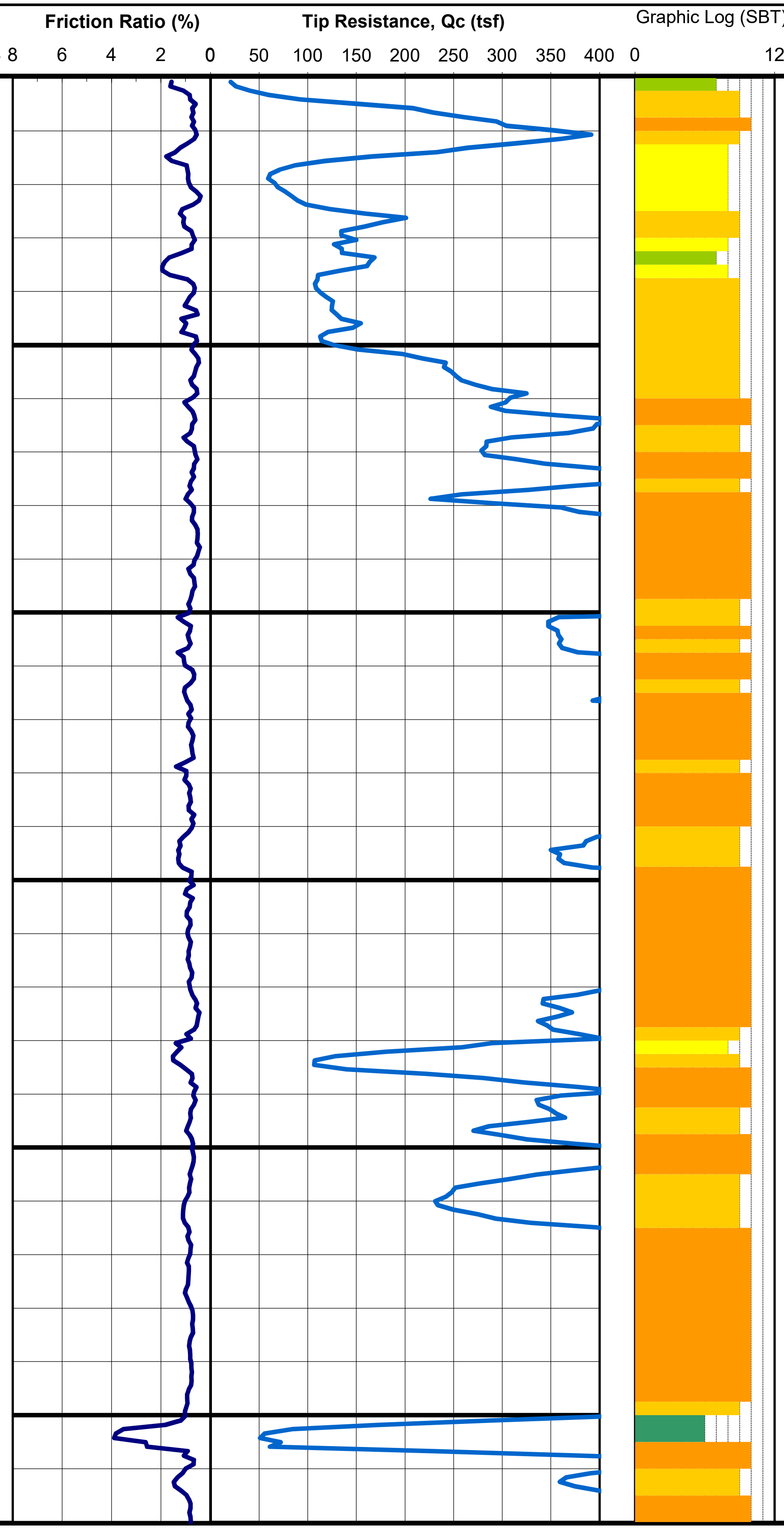
Project Name: Rio Mesa HS Home Bleachers
Project No.: 303280-002
Location: See Site Exploration Plan

CPT Vendor: **Kehoe Testing and Engineering**
Truck Mounted Electric
Cone with 23-ton reaction
Date: 1/14/2020

DEPTH (FEET)

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

End of Sounding @ 54.6 feet



Earth Systems

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Rio Mesa HS Home Bleachers Project No: 303280-002 Date: 01/14/20

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

Est. GWT (feet): **56.0** Dr correlation: 0 Baldi Qc/N: 1 Robertson 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	42.14	1.18	Silty Sand to Sandy Silt	SM/ML	medium dense	110	3.0	14	0.014	0.014	1.18	0.63	1.70	67.7	2.09	96.9	24	19	61	34		
0.30	1.0	151.11	0.71	Sand	SP	very dense	100	5.0	30	0.040	0.040	0.71	0.50	1.70	242.8	1.52	242.8	51	49	100	41		
0.46	1.5	260.83	0.70	Sand	SP	very dense	100	5.0	52	0.065	0.065	0.70	0.50	1.70	419.1	1.36	419.1	89	84	100	46		
0.61	2.0	349.13	0.63	Gravelly Sand to Sand	SW	very dense	110	6.0	58	0.091	0.091	0.63	0.50	1.70	561.0	1.25	561.0	99	112	100	47		
0.76	2.5	313.03	0.93	Sand	SP	very dense	100	5.0	63	0.118	0.118	0.93	0.50	1.70	503.0	1.41	503.0	106	101	100	48		
0.91	3.0	172.23	1.59	Sand to Silty Sand	SP/SM	very dense	100	4.0	43	0.143	0.143	1.59	0.53	1.70	276.7	1.75	297.2	73	59	100	44		
1.07	3.5	73.11	0.92	Sand to Silty Sand	SP/SM	dense	100	4.0	18	0.168	0.168	0.92	0.56	1.70	117.5	1.83	133.0	31	27	84	36		
1.22	4.0	64.67	0.85	Sand to Silty Sand	SP/SM	medium dense	100	4.0	16	0.193	0.193	0.85	0.56	1.70	103.9	1.85	119.3	27	24	78	35		
1.37	4.5	83.24	0.47	Sand to Silty Sand	SP/SM	dense	100	4.0	21	0.218	0.218	0.47	0.50	1.70	133.7	1.61	133.7	35	27	89	37		
1.52	5.0	126.75	1.02	Sand to Silty Sand	SP/SM	very dense	100	4.0	32	0.243	0.243	1.03	0.52	1.70	203.7	1.69	210.3	54	42	100	41		
1.68	5.5	167.65	0.99	Sand	SP	very dense	100	5.0	34	0.268	0.268	0.99	0.50	1.70	269.4	1.60	269.4	57	54	100	42		
1.83	6.0	137.22	0.69	Sand	SP	dense	100	5.0	27	0.293	0.293	0.69	0.50	1.70	220.5	1.55	220.5	47	44	100	40		
1.98	6.5	146.32	1.19	Sand to Silty Sand	SP/SM	very dense	100	4.0	37	0.318	0.318	1.19	0.52	1.70	235.1	1.70	244.0	62	49	100	43		
2.13	7.0	152.76	1.91	Silty Sand to Sandy Silt	SM/ML	very dense	110	3.0	51	0.344	0.344	1.91	0.56	1.70	245.5	1.85	281.0	87	56	100	46		
2.29	7.5	109.36	1.08	Sand to Silty Sand	SP/SM	dense	100	4.0	27	0.370	0.370	1.08	0.53	1.70	175.7	1.75	188.6	45	38	100	40		
2.44	8.0	113.57	0.70	Sand	SP	dense	100	5.0	23	0.395	0.395	0.70	0.50	1.64	175.7	1.63	175.7	36	35	100	38		
2.59	8.5	125.19	0.84	Sand	SP	dense	100	5.0	25	0.420	0.420	0.85	0.51	1.60	188.8	1.66	190.3	39	38	100	38		
2.74	9.0	139.56	0.89	Sand	SP	dense	100	5.0	28	0.445	0.445	0.89	0.50	1.55	203.8	1.65	204.1	42	41	100	39		
2.90	9.5	126.82	0.94	Sand	SP	dense	100	5.0	25	0.470	0.470	0.94	0.52	1.52	182.6	1.70	189.3	37	38	100	38		
3.05	10.0	130.94	0.66	Sand	SP	dense	100	5.0	26	0.495	0.495	0.67	0.50	1.46	180.9	1.60	180.9	37	36	100	38		
3.20	10.5	218.95	0.51	Sand	SP	very dense	100	5.0	44	0.520	0.520	0.52	0.50	1.43	295.2	1.37	295.2	61	59	100	42		
3.35	11.0	246.56	0.61	Sand	SP	very dense	100	5.0	49	0.545	0.545	0.61	0.50	1.39	324.7	1.39	324.7	67	65	100	43		
3.51	11.5	273.30	0.70	Sand	SP	very dense	100	5.0	55	0.570	0.570	0.70	0.50	1.36	351.9	1.41	351.9	72	70	100	44		
3.66	12.0	312.17	0.76	Sand	SP	very dense	100	5.0	62	0.595	0.595	0.76	0.50	1.33	393.5	1.41	393.5	81	79	100	45		
3.81	12.5	316.44	0.76	Gravelly Sand to Sand	SW	very dense	110	6.0	53	0.621	0.621	0.76	0.50	1.30	390.3	1.41	390.3	67	78	100	43		
3.96	13.0	403.23	0.69	Gravelly Sand to Sand	SW	very dense	110	6.0	67	0.649	0.649	0.69	0.50	1.28	486.7	1.32	486.7	83	97	100	46		
4.11	13.5	320.39	0.93	Sand	SP	very dense	100	5.0	64	0.675	0.675	0.94	0.50	1.25	379.1	1.49	379.1	78	76	100	45		
4.27	14.0	281.28	0.62	Sand	SP	very dense	100	5.0	56	0.700	0.700	0.63	0.50	1.23	326.9	1.40	326.9	67	65	100	44		
4.42	14.5	351.34	0.61	Gravelly Sand to Sand	SW	very dense	110	6.0	59	0.726	0.726	0.61	0.50	1.21	400.8	1.33	400.8	69	80	100	44		
4.57	15.0	467.81	0.73	Gravelly Sand to Sand	SW	very dense	110	6.0	78	0.754	0.754	0.73	0.50	1.18	523.9	1.32	523.9	90	105	100	46		
4.72	15.5	320.30	0.83	Sand	SP	very dense	100	5.0	64	0.780	0.780	0.83	0.50	1.16	352.6	1.47	352.6	73	71	100	44		
4.88	16.0	314.35	0.78	Gravelly Sand to Sand	SW	very dense	110	6.0	52	0.806	0.806	0.78	0.50	1.15	340.4	1.46	340.4	58	68	100	42		
5.03	16.5	438.30	0.69	Gravelly Sand to Sand	SW	very dense	110	6.0	73	0.834	0.834	0.69	0.50	1.13	466.7	1.33	466.7	80	93	100	45		
5.18	17.0	508.54	0.51	Gravelly Sand to Sand	SW	very dense	110	6.0	85	0.861	0.861	0.51	0.50	1.11	532.7	1.19	532.7	91	107	100	47		
5.33	17.5	481.64	0.48	Gravelly Sand to Sand	SW	very dense	110	6.0	80	0.889	0.889	0.48	0.50	1.09	496.7	1.19	496.7	85	99	100	46		
5.49	18.0	504.33	0.61	Gravelly Sand to Sand	SW	very dense	110	6.0	84	0.916	0.916	0.61	0.50	1.07	512.2	1.26	512.2	88	102	100	46		
5.64	18.5	502.88	0.79	Gravelly Sand to Sand	SW	very dense	110	6.0	84	0.944	0.944	0.79	0.50	1.06	503.3	1.36	503.3	86	101	100	46		
5.79	19.0	495.05	0.66	Gravelly Sand to Sand	SW	very dense	110	6.0	83	0.971	0.971	0.66	0.50	1.04	488.4	1.30	488.4	84	98	100	46		
5.94	19.5	458.06	0.81	Gravelly Sand to Sand	SW	very dense	110	6.0	76	0.999	0.999	0.82	0.50	1.03	445.6	1.40	445.6	76	89	100	45		
6.10	20.0	459.35	1.00	Sand	SP	very dense	100	5.0	92	1.025	1.025	1.01	0.50	1.02	441.1	1.48	441.1	91	88	100	47		
6.25	20.5	350.36	0.89	Sand	SP	very dense	100	5.0	70	1.050	1.050	0.89	0.50	1.00	332.4	1.51	332.4	68	66	100	44		
6.40	21.0	358.87	0.86	Gravelly Sand to Sand	SW	very dense	110	6.0	60	1.076	1.076	0.86	0.50	0.99	336.3	1.49	336.3	58	67	100	42		
6.55	21.5	396.52	1.10	Sand	SP	very dense	100	5.0	79	1.103	1.103	1.10	0.50	0.98	367.1	1.55	367.1	76	73	100	45		
6.71	22.0	443.78	0.93	Gravelly Sand to Sand	SW	very dense	110	6.0	74	1.129	1.129	0.94	0.50	0.97	406.1	1.47	406.1	70	81	100	44		
6.86	22.5	542.18	0.70	Gravelly Sand to Sand	SW	very dense	110	6.0	90	1.156	1.156	0.70	0.50	0.96	490.2	1.32	490.2	84	98	100	46		
7.01	23.0	461.80	1.02	Sand	SP	very dense	100	5.0	92	1.183	1.183	1.03	0.50	0.95	412.9	1.50	412.9	85	83	100	46		
7.16	23.5	461.75	0.83	Gravelly Sand to Sand	SW	very dense	110	6.0	77	1.209	1.209	0.83	0.50	0.94	408.3	1.43	408.3	70	82	100	44		
7.32	24.0	481.85	0.85	Gravelly Sand to Sand	SW	very dense	110	6.0	80	1.236	1.236	0.85	0.50	0.93	421.3	1.43	421.3	72	84	100	44		
7.47	24.5	423.11	0.78	Gravelly Sand to Sand	SW	very dense	110	6.0	71	1.264	1.264	0.78	0.50	0.91	365.9	1.44	365.9	63	73	100	43		
7.62	25.0	420.09	0.74	Gravelly Sand to Sand	SW	very dense	110	6.0	70	1.291	1.291	0.75	0.50	0.91	359.4	1.42	359.4	62	72	100	43		
7.77	25.5	422.35	0.79	Gravelly Sand to Sand	SW	very dense	110	6.0	70	1.319	1.319	0.80	0.50	0.90	357.6	1.45	357.6	61	72	100	43		
7.92	26.0	522.86	1.11	Sand	SP	very dense	100	5.0	105	1.345	1.345	1.11	0.50	0.89	438.3	1.51	438.3	90	88	100	46		
8.08	26.5	464.81	0.90	Gravelly Sand to Sand	SW	very dense	110	6.0	77	1.371	1.371	0.90	0.50	0.88	385.9	1.47	385.9	66	77	100	43		
8.23	27.0	424.61	0.82	Gravelly Sand to Sand	SW	very dense	110	6.0	71	1.399	1.399	0.82	0.50	0.87	349.0	1.47	349.0	60	70	100	42		
8.38	27.5	517.35	0.76	Gravelly Sand to Sand	SW	very dense	110	6.0	86	1.426	1.426	0.76	0.50	0.86	421.2	1.39	421.2	72	84	100	44		
8.53	28.0	479.05	0.77	Gravelly Sand to Sand	SW	very dense	110	6.0	80	1.454	1.454	0.77	0.50	0.85	386.3	1.42	386.3	66	77	100	43		
8.69	28.5	388.74	1.18	Sand	SP	very dense	100	5.0	78	1.480	1.480	1.18	0.50	0.85	310.7	1.62	310.7	64	62	100	43		
8.84	29.0	355.61	1.28	Sand	SP	very dense	100	5.0	71	1.505	1.505	1.29	0.51	0.84	280.7	1.68	286.8	58	57	100	42		
8.99	29.5	420.72	1.05	Sand	SP	very dense	100	5.0	84	1.530	1.530	1.05	0.50	0.83	330.7	1.56	330.7	68	66	100	44		
9.14	30.0	551.01	0.76	Gravelly Sand to Sand	SW	very dense	110	6.0	92	1.556	1.556	0.76	0.50	0.82	429.4	1.38	429.4	74	86	100	44		
9.30	30.5	636.82	0.89	Gravelly Sand to Sand	SW	very dense	110	6.0	106	1.584	1.584	0.90	0.50	0.82	492.0	1.41	492.0	84	98	100	46		
9.45	31.0	568.13	0.86	Gravelly Sand to Sand	SW	very dense	110	6.0	95	1.611	1.611	0.86	0.50	0.81	435.1	1.42	435.1	75	87	100	45		
9.60	31.5	542.47	0.85	Gravelly Sand to Sand	SW	very dense	110	6.0	90	1.639	1.639	0.86	0.50	0.80	412.0	1.44	412.0	71	82	100	44		
9.75	32.0	462.72	0.90	Gravelly Sand to Sand	SW	very dense	110	6.0	77	1.666	1.666	0.90	0.50	0.80	348.5	1.50	348.5	60	70	100	42		
9.91	32.5	426.17	0.82	Gravelly Sand to Sand	SW	very dense	110	6.0	71	1.694	1.694	0.83	0.50	0.79	318.4	1.49	318.4	55	64	100	41		
10.06	33.0	440.21	0.87	Gravelly Sand to Sand	SW	very dense	110	6.0	73	1.721	1.721	0.88	0.50	0.78	326.2	1.51	326.2	56	65	100	42		
10.21	33.5	458.26	0.76	Gravelly Sand to Sand	SW	very dense	110	6.0	76	1.749	1.749	0.77	0.50	0.78	336.9	1.45	336.9	58	67	100	42		
10.36	34.0	406.85	0.83	Gravelly Sand to Sand	SW	very dense	110	6.0	68	1.776	1.776	0.84	0.50	0.77	296.8	1.52	296.8	51	59	100	41		
10.52	34.5	353.66	0.63	Gravelly Sand to Sand	SW	dense	110	6.0	59	1.804	1.804	0.63	0.50	0.77	256.0	1.47	256.0	44	51	100	39		
10.67	35.0	362.37	0.50	Gravelly Sand to Sand	SW	dense	110	6.0	60	1.831	1.831	0.51	0.50	0.76	260.3	1.40	260.3	45	52	100	39		
10.82	35.5	345.17	0.58	Gravelly Sand to Sand	SW	dense	110	6.0	58	1.859	1.859	0.58	0.50	0.75	246.1	1.46	246.1	42	49	100	39		
10.97	36.0	357.21	1.05	Sand	SP	very dense	100	5.0	71	1.885	1.885	1.05	0.50	0.75	252.8	1.64	252.8	52	51	100	41		
11.13	36.5	168.56	1.38	Sand to Silty Sand	SP/SM	dense	100	4.0	42	1.910	1.910	1.40	0.60	0.70	111.7	1.97	141.2	30	28	81	36		
11.28	37.0	155.92	0.97	Sand	SP	medium dense	100	5.0	31	1.935	1.935	0.98	0.58	0.71	103.9	1.89	122.9	22	25	78	34		

Earth Systems

CONE PENETROMETER INTERPRETATION

(based on Robertson & Campanella, 1989)

Project: Rio Mesa HS Home Bleachers Project No: 303280-002 Date: 01/14/20

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

Est. GWT (feet): **56.0** Dr correlation: 0 Baldi Qc/N: 1 Robertson 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.)	Su (tsf)	Nk: 17 OCR
11.43	37.5	326.50	0.69	Gravelly Sand to Sand	SW	dense	110	6.0	54	1.961	1.961	0.69	0.50	0.73	226.7	1.54	226.7	39	45	100	38		
11.58	38.0	372.93	0.64	Gravelly Sand to Sand	SW	dense	110	6.0	62	1.989	1.989	0.64	0.50	0.73	257.1	1.48	257.1	44	51	100	39		
11.73	38.5	346.62	0.75	Gravelly Sand to Sand	SW	dense	110	6.0	58	2.016	2.016	0.75	0.50	0.72	237.3	1.55	237.3	41	47	100	39		
11.89	39.0	325.52	0.84	Sand	SP	dense	100	5.0	65	2.043	2.043	0.85	0.50	0.72	221.4	1.61	221.4	46	44	100	40		
12.04	39.5	298.46	0.85	Sand	SP	dense	100	5.0	60	2.068	2.068	0.86	0.50	0.71	201.5	1.64	201.5	42	40	100	39		
12.19	40.0	419.48	0.71	Gravelly Sand to Sand	SW	dense	110	6.0	70	2.094	2.094	0.71	0.50	0.71	281.8	1.48	281.8	48	56	100	40		
12.34	40.5	445.66	0.68	Gravelly Sand to Sand	SW	very dense	110	6.0	74	2.121	2.121	0.68	0.50	0.71	297.5	1.45	297.5	51	59	100	41		
12.50	41.0	338.84	0.80	Gravelly Sand to Sand	SW	dense	110	6.0	56	2.149	2.149	0.80	0.50	0.70	224.7	1.59	224.7	39	45	100	38		
12.65	41.5	258.65	0.84	Sand	SP	dense	100	5.0	52	2.175	2.175	0.85	0.52	0.69	168.2	1.69	173.7	35	35	98	37		
12.80	42.0	235.74	1.00	Sand	SP	dense	100	5.0	47	2.200	2.200	1.01	0.55	0.67	149.4	1.78	163.5	32	33	93	37		
12.95	42.5	272.45	1.10	Sand	SP	dense	100	5.0	54	2.225	2.225	1.11	0.54	0.67	172.3	1.77	186.6	37	37	99	38		
13.11	43.0	386.74	0.92	Sand	SP	very dense	100	5.0	77	2.250	2.250	0.93	0.50	0.69	250.7	1.60	250.7	52	50	100	41		
13.26	43.5	451.13	0.86	Gravelly Sand to Sand	SW	dense	110	6.0	75	2.276	2.276	0.86	0.50	0.68	290.7	1.53	290.7	50	58	100	41		
13.41	44.0	476.59	0.83	Gravelly Sand to Sand	SW	very dense	110	6.0	79	2.304	2.304	0.83	0.50	0.68	305.3	1.51	305.3	52	61	100	41		
13.56	44.5	460.57	0.89	Gravelly Sand to Sand	SW	very dense	110	6.0	77	2.331	2.331	0.90	0.50	0.67	293.3	1.54	293.3	50	59	100	41		
13.72	45.0	457.33	0.89	Gravelly Sand to Sand	SW	dense	110	6.0	76	2.359	2.359	0.89	0.50	0.67	289.5	1.54	289.5	50	58	100	40		
13.87	45.5	449.25	0.98	Gravelly Sand to Sand	SW	dense	110	6.0	75	2.386	2.386	0.99	0.50	0.67	282.7	1.58	282.7	48	57	100	40		
14.02	46.0	423.45	0.79	Gravelly Sand to Sand	SW	dense	110	6.0	71	2.414	2.414	0.79	0.50	0.66	265.0	1.53	265.0	45	53	100	40		
14.17	46.5	430.94	0.70	Gravelly Sand to Sand	SW	dense	110	6.0	72	2.441	2.441	0.71	0.50	0.66	268.1	1.49	268.1	46	54	100	40		
14.33	47.0	446.26	0.75	Gravelly Sand to Sand	SW	dense	110	6.0	74	2.469	2.469	0.76	0.50	0.65	276.1	1.51	276.1	47	55	100	40		
14.48	47.5	457.48	0.83	Gravelly Sand to Sand	SW	dense	110	6.0	76	2.496	2.496	0.83	0.50	0.65	281.5	1.53	281.5	48	56	100	40		
14.63	48.0	511.00	0.78	Gravelly Sand to Sand	SW	very dense	110	6.0	85	2.524	2.524	0.78	0.50	0.65	312.7	1.48	312.7	54	63	100	41		
14.78	48.5	501.91	0.75	Gravelly Sand to Sand	SW	very dense	110	6.0	84	2.551	2.551	0.75	0.50	0.64	305.5	1.48	305.5	52	61	100	41		
14.94	49.0	551.14	0.86	Gravelly Sand to Sand	SW	very dense	110	6.0	92	2.579	2.579	0.86	0.50	0.64	333.7	1.49	333.7	57	67	100	42		
15.09	49.5	581.26	0.94	Gravelly Sand to Sand	SW	very dense	110	6.0	97	2.606	2.606	0.95	0.50	0.64	350.0	1.51	350.0	60	70	100	42		
15.24	50.0	408.07	1.08	Sand	SP	very dense	100	5.0	82	2.633	2.633	1.08	0.51	0.63	242.5	1.66	244.8	50	49	100	41		
15.39	50.5	104.12	3.05	Sandy Silt to Clayey Silt	ML	medium dense	110	2.5	42	2.659	2.659	3.13	0.75	0.50	49.1	2.47	129.1	26	26	47	35		
15.54	51.0	61.42	3.02	Sandy Silt to Clayey Silt	ML	hard	110	2.5	25	2.686	2.686	3.16	0.81	0.47	27.2	2.66		25				3.45	6.6
15.70	51.5	372.77	0.88	Gravelly Sand to Sand	SW	dense	110	6.0	62	2.714	2.714	0.88	0.50	0.62	220.0	1.62	220.0	38	44	100	38		
15.85	52.0	482.57	0.93	Gravelly Sand to Sand	SW	dense	110	6.0	80	2.741	2.741	0.94	0.50	0.62	283.4	1.57	283.4	49	57	100	40		
16.00	52.5	366.45	1.41	Sand	SP	dense	100	5.0	73	2.768	2.768	1.42	0.55	0.59	204.0	1.80	225.3	44	45	100	39		
16.15	53.0	439.58	1.01	Sand	SP	very dense	120	5.0	88	2.795	2.795	1.01	0.50	0.62	255.6	1.62	255.6	53	51	100	41		
16.31	53.5	547.08	0.81	Gravelly Sand to Sand	SW	very dense	120	6.0	91	2.825	2.825	0.82	0.50	0.61	316.4	1.49	316.4	54	63	100	41		
16.46	54.0	609.06	0.79	Gravelly Sand to Sand	SW	very dense	120	6.0	102	2.855	2.855	0.79	0.50	0.61	350.4	1.45	350.4	60	70	100	42		

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

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 1809.7

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 on remolded 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. Settlement characteristics were developed from the results of one-dimensional Consolidation tests performed in general accordance with ASTM D 2435. The samples were typically loaded to 0.5 ksf, flooded with water, and then incrementally loaded to 1.0, 2.0, 4.0, 8.0, and 16.0 ksf. The samples were allowed to consolidate under each load increment. Rebound was measured under reverse alternate loading. Compression was measured by dial gauges accurate to 0.0001 inch. Results of the consolidation tests are presented in this Appendix as curves plotting percent consolidation versus log of pressure.

E. 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% saturation. The sample was then submerged in water for 24 hours, and the amount of expansion was recorded with a dial indicator.

F. 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.

G. 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.

TABULATED LABORATORY TEST RESULTS

	REMOLDED SAMPLES	
BORING AND DEPTH	B-1 @ 0-5’	
USCS	SM	
MAXIMUM DENSITY (pcf)	123.0	127.0^
OPTIMUM MOISTURE (%)	10.0	9.5^
COHESION (psf)	90*	40**
ANGLE OF INTERNAL FRICTION	36°*	32°**
EXPANSION INDEX	0	
pH	8.3	
SOLUBLE CHLORIDES (mg/Kg)	13	
RESISTIVITY (OHMs-cm)	5,000	
SOLUBLE SULFATES (mg/Kg)	130	

^ = Values Corrected for Oversized Material

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

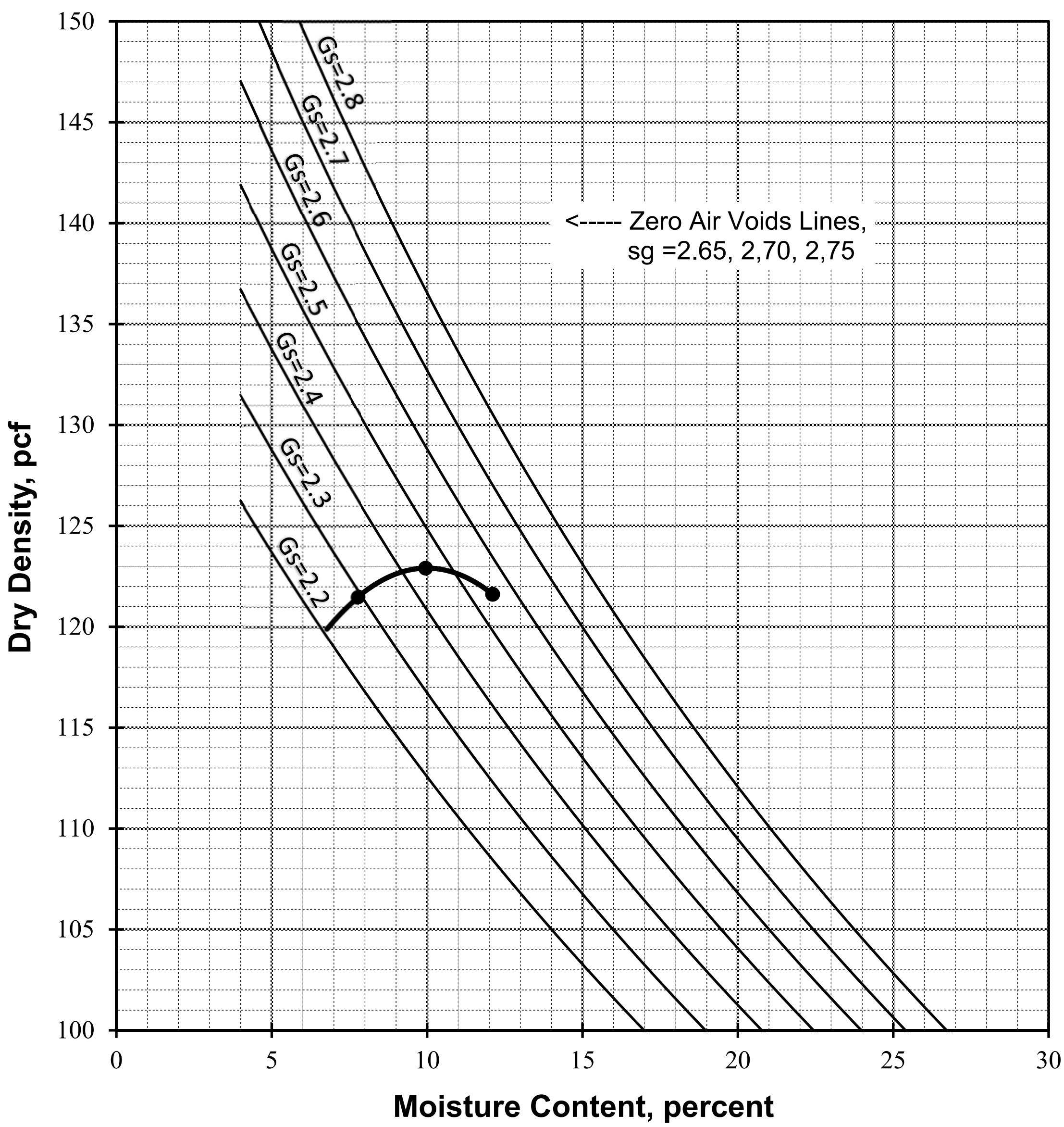
File Number: 303280-002 Lab Number: 098363

MAXIMUM DENSITY / OPTIMUM MOISTURE ASTM D 1557-12 (Modified)

Job Name:	Rio Mesa High School Bleachers	Procedure Used: B
Sample ID:	B 1 @ 0-5'	Prep. Method: Moist
Date:	1/21/2020	Rammer Type: Automatic
Description:	Brown Silty Sand	
SG:	2.45	

Maximum Density: **123 pcf**
Optimum Moisture: **10%**

Sieve Size	% Retained
3/4"	0.0
3/8"	14.4
#4	0.0



File Number: 303280-002 Lab Number: 098363

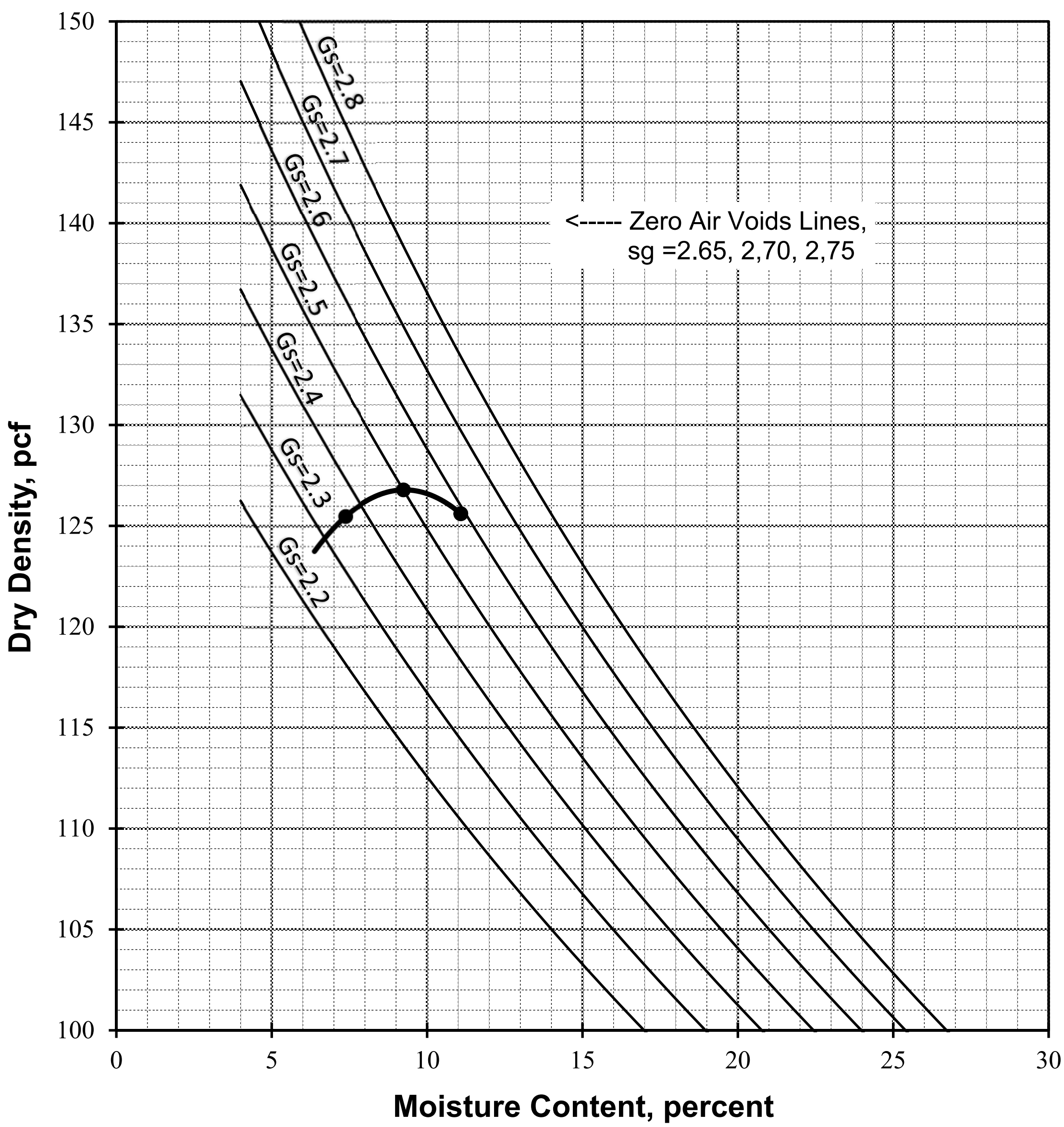
MAXIMUM DENSITY / OPTIMUM MOISTURE ASTM D 1557-12 (Modified)

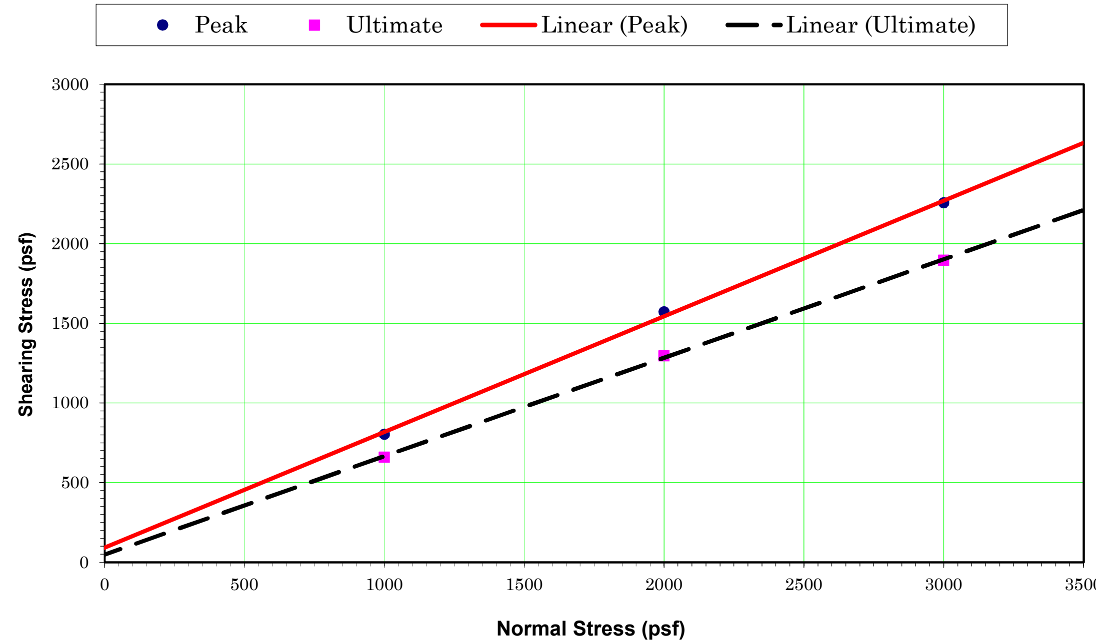
Job Name: Rio Mesa High School Bleachers
Sample ID: B 1 @ 0-5'
Procedure Used: B
Prep. Method: Moist

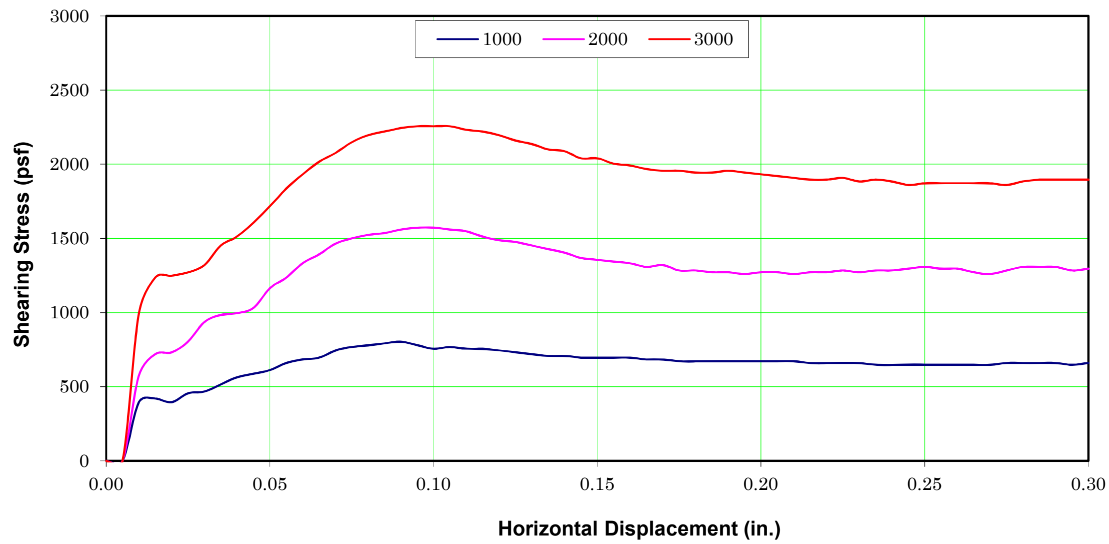
Date: 1/21/2020
Rammer Type: Automatic
Description: Brown Silty Sand
SG: 2.50

Maximum Density: **127 pcf**
Optimum Moisture: **9.5%**
Corrected for Oversize (ASTM D4718)

Sieve Size	% Retained
3/4"	0.0
3/8"	14.4
#4	0.0







DIRECT SHEAR DATA*

Sample Location: B 1 @ 0-5'
Sample Description: Silty Sand
Dry Density (pcf): 110.6
Intial % Moisture: 10
Average Degree of Saturation: 86.1
Shear Rate (in/min): 0.005 in/min

Normal stress (psf)	1000	2000	3000
Peak stress (psf)	804	1572	2256
Ultimate stress (psf)	660	1296	1896

	Peak	Ultimate
ϕ Angle of Friction (degrees):	36	32
c Cohesive Strength (psf):	90	40

Test Type: Peak & Ultimate

* Test Method: ASTM D-3080

DIRECT SHEAR TEST

Rio Mesa High School Bleachers

Earth Systems

2/19/2020 | 303280-002

File No.: 303280-002

EXPANSION INDEX

ASTM D-4829, UBC 18-2

Job Name: Rio Mesa High School Bleachers
Sample ID: B 1 @ 0-5'
Soil Description: SM

Initial Moisture, %:	9.1
Initial Compacted Dry Density, pcf:	112.5
Initial Saturation, %:	50
Final Moisture, %:	22.2
Volumetric Swell, %:	0.0

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

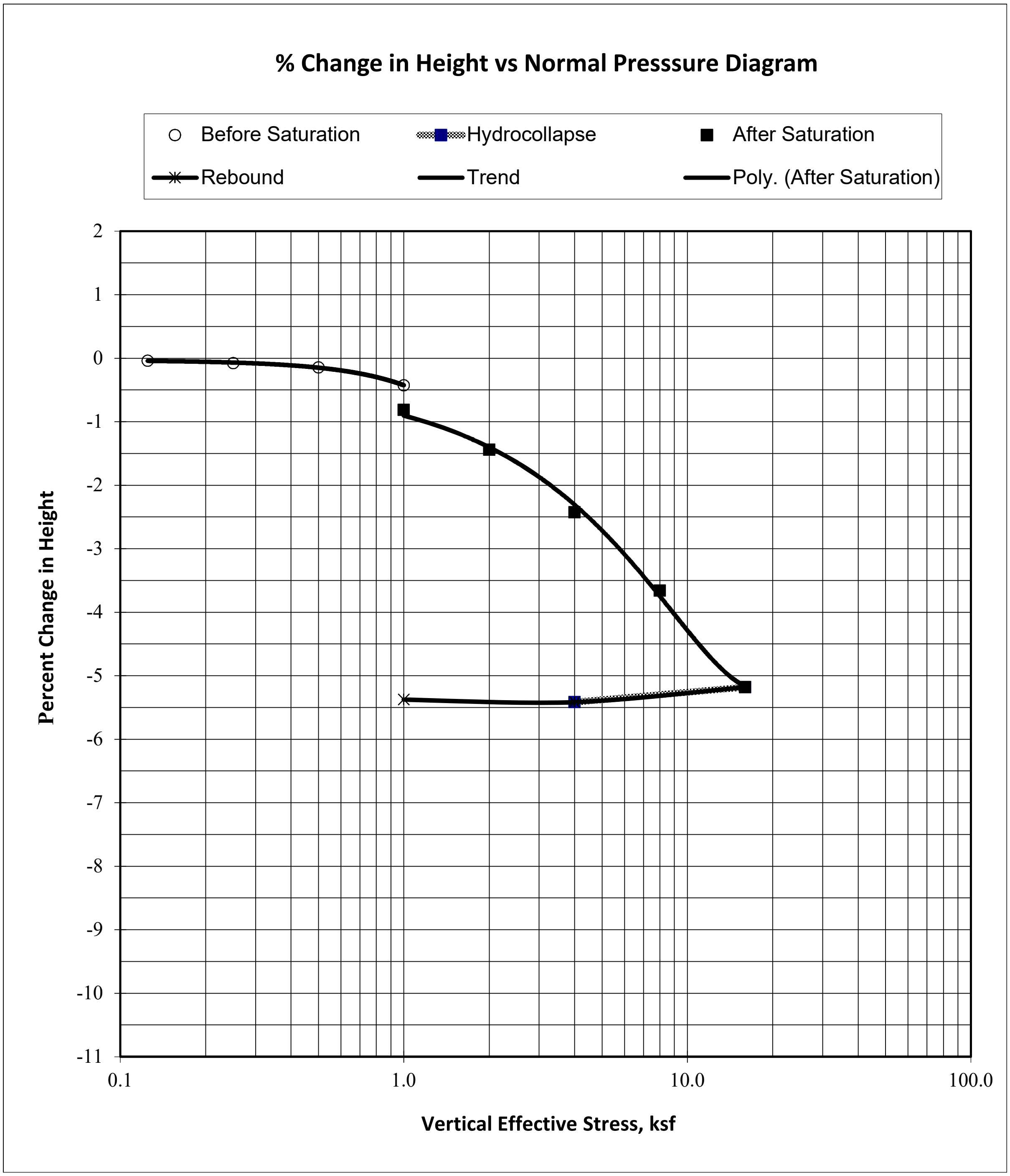
EI	UBC Classification
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
130+	Very High

CONSOLIDATION TEST

ASTM D 2435-90 & D5333

Rio Mesa High School Bleachers
B 1 @ 5'
SW
Ring Sample

Initial Dry Density: 103.4 pcf
Initial Moisture, %: 8.1%
Specific Gravity: 2.67 (assume
Initial Void Ratio: 0.613

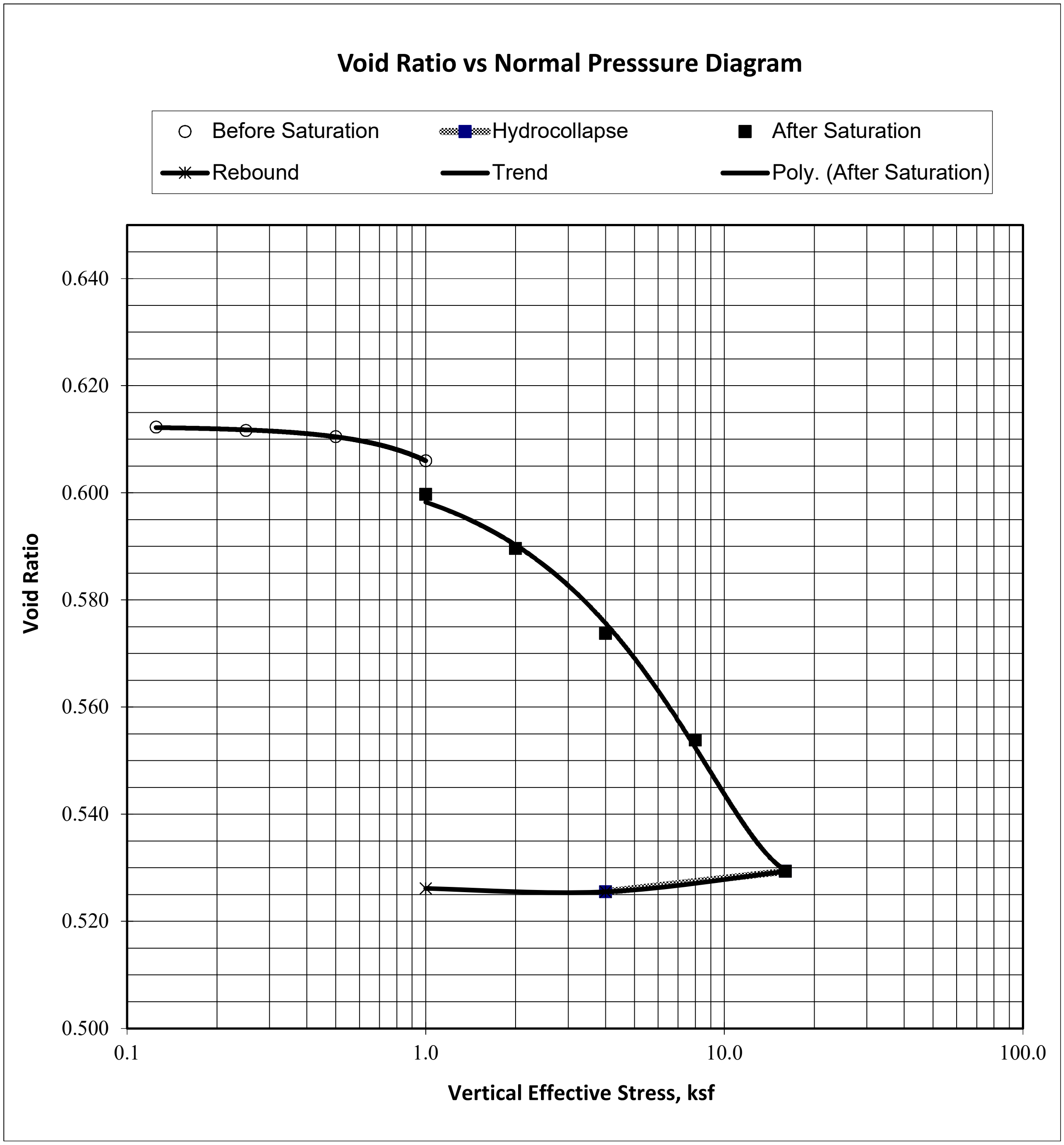


CONSOLIDATION TEST

ASTM D 2435-90

Rio Mesa High School Bleachers
B 1 @ 5'
SW
Ring Sample

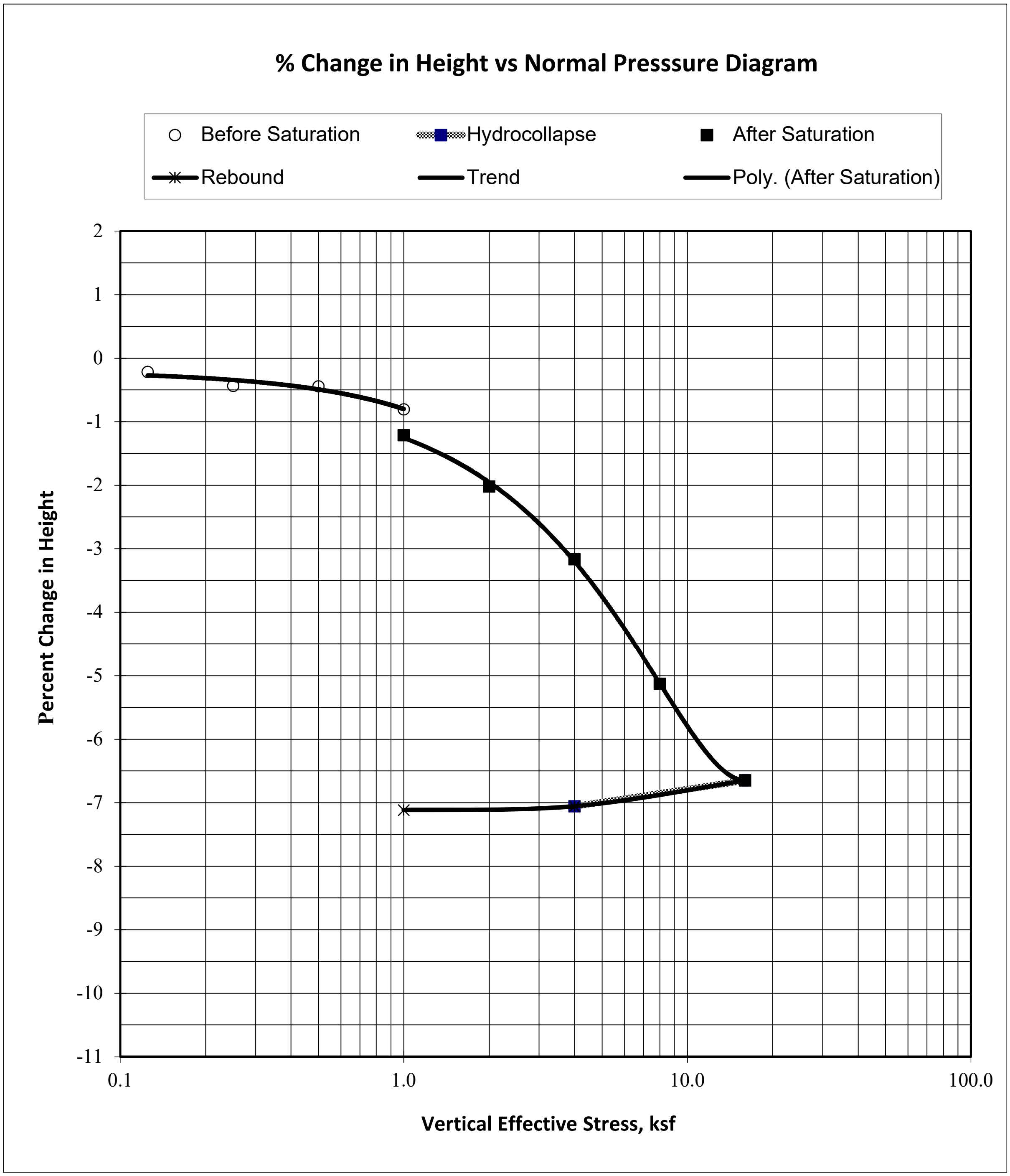
Initial Dry Density: 103.4
Initial Moisture, %: 8.1
Specific Gravity: 2.67 (assume
Initial Void Ratio: 0.613



CONSOLIDATION TEST

ASTM D 2435-90 & D5333

Rio Mesa High School Bleachers		Initial Dry Density:	107.4 pcf
B 2 @ 7.5'		Initial Moisture, %:	7.0%
GW		Specific Gravity:	2.67 (assume
Ring Sample		Initial Void Ratio:	0.552

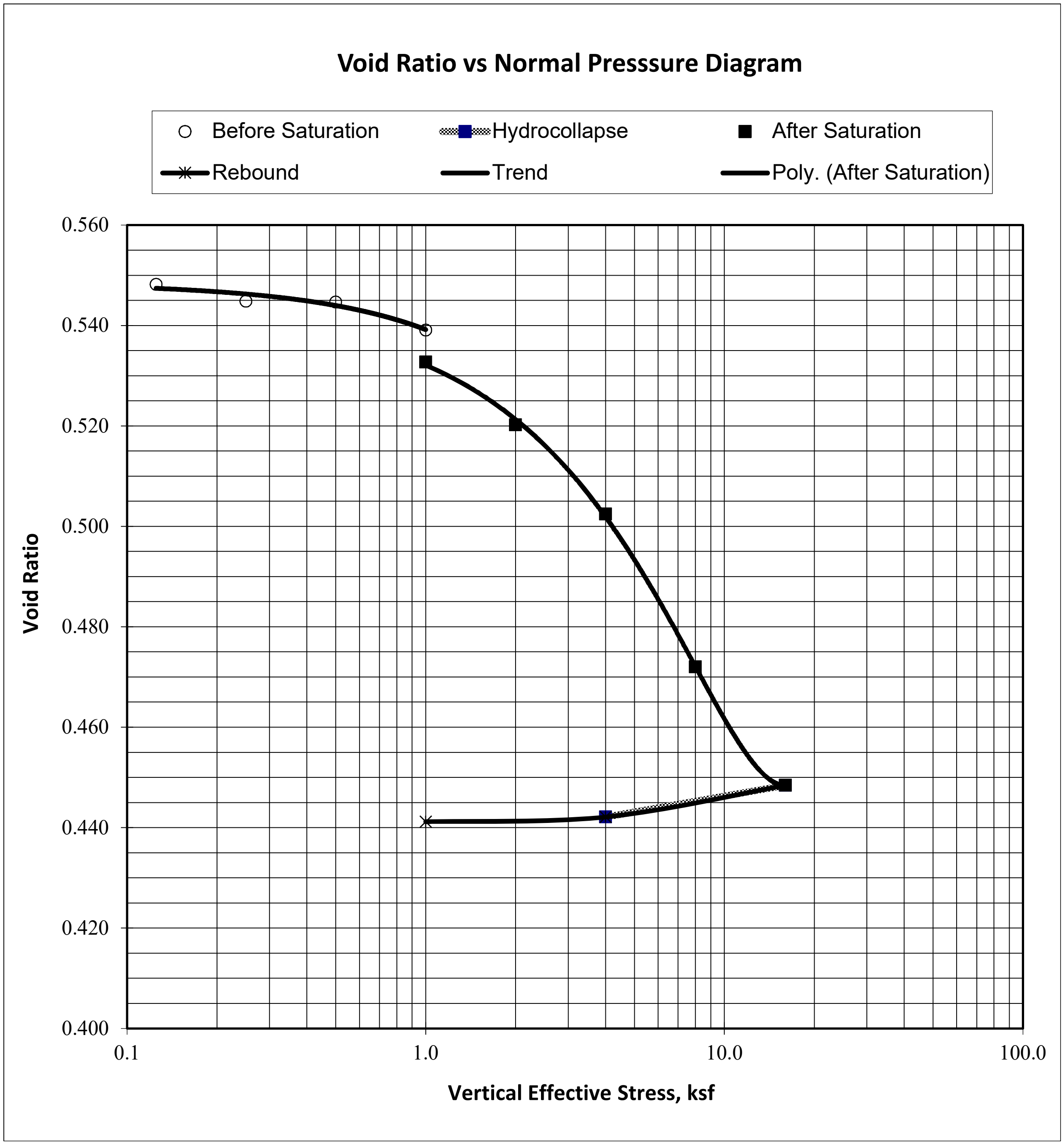


CONSOLIDATION TEST

ASTM D 2435-90

Rio Mesa High School Bleachers
B 2 @ 7.5'
GW
Ring Sample

Initial Dry Density: 107.4
Initial Moisture, %: 7.0
Specific Gravity: 2.67 (assume
Initial Void Ratio: 0.552



CERTIFICATE OF ANALYSIS

Client: Earth Systems Pacific
CAS LAB NO: 200116-01
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)	8.3	S.U.	1	---	9045	01/23/20
Resistivity*	5000	Ohms-cm	1	---	SM 120.1M	01/23/20
Chloride	13	mg/Kg	1	0.3	300.0M	01/23/20
Sulfate	130	mg/Kg	1	0.3	300.0M	01/23/20

*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 1809.7
PRESCRIPTIVE FOOTINGS FOR SUPPORTING WALLS OF LIGHT FRAME CONSTRUCTION*

WEIGHTED EXPANSION INDEX (13)	FOUNDATION FOR SLAB & RAISED FLOOR SYSTEM (4) (8)							CONCRETE SLABS (8) (12)		PREMOISTENING OF SOILS UNDER FOOTINGS, PIERS AND SLABS (4) (5)	RESTRICTION ON PIERS UNDER RAISED FLOORS
	NUMBER OF STORIES	STEM THICKNESS	FOOTING WIDTH	FOOTING THICKNESS	ALL PERIMETER FOOTINGS (5)	INTERIOR FOOTINGS FOR SLAB AND RAISED FLOORS (5)	REINFORCEMENT FOR CONTINUOUS FOUNDATIONS (2) (6)	3-1/2" MINIMUM THICKNESS			
					DEPTH BELOW NATURAL SURFACE OF GROUND AND FINISH GRADE			REINFORCEMENT (3)	TOTAL THICKNESS OF SAND (10)		
		(INCHES)									
0 - 20 Very Low (non-expansive)	1 2 3	6 8 10	12 15 18	6 6 8	12 18 24	12 18 24	1-#4 top and bottom	#4 @ 48" o.c. each way, or #3 @ 36" o.c. each way	2"	Moistening of ground recommended prior to placing concrete	Piers allowed for single floor loads only
21-50 Low	1 2 3	6 8 10	12 15 18	6 6 8	15 18 24	12 18 24	1-#4 top and bottom	#4 @ 48" o.c. each way, or #3 @ 36" o.c. each way	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	6 8	12 15	6 6	21 21	12 18	1-#4 top and bottom	#3 @ 24" o.c. each way	4"	130% of optimum moisture required to a depth of 27" below lowest adjacent grade. Testing required	Piers not allowed
	3	10	18	8	24	24	#3 bars @ 24" in ext. footing Bend 3' into slab (7)				
91-130 High	1 2	6 8	12 15	6 6	27 27	12 18	2-#4 Top and Bottom	#3 @ 24" o.c. each way	4"	140% of optimum moisture required to a depth of 33" below lowest adjacent grade. Testing required.	Piers not allowed
	3	10	18	8	27	24	#3 bars @ 24" in ext. footing Bend 3' into slab (7)				
Above 130 Very High	Special design by licensed engineer/architect										

*Refer to next page for footnotes (1) through (14).

FOOTNOTES TO TABLE 1809.7

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:	303280-002
Job Name:	RMHS Bleachers
Calc Date:	
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
2.5	15.1	2.5	0.166
5.0	18.3	2.5	0.137
7.5	24.6	2.5	0.102
10.0	23.9	2.5	0.105
12.5	20.0	2.5	0.125
15.0	26.5	2.5	0.094
17.5	28.0	2.5	0.089
20.0	47.9	2.5	0.052
22.5	33.0	2.5	0.076
25.0	32.0	2.5	0.078
27.5	50.0	2.5	0.050
30.0	36.0	2.5	0.069
32.5	36.0	2.5	0.069
35.0	38.0	2.5	0.066
37.5	54.0	2.5	0.046
40.0	28.0	2.5	0.089
42.5	30.0	2.5	0.083
45.0	52.0	2.5	0.048
47.5	55.0	2.5	0.045
50.0	42.0	2.5	0.060
52.5	69.0	2.5	0.036
100.0	50.00	47.5	0.950

Total Thickness of Soil =	100.00	ft
N-bar Value =	37.9	*
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)

Seismic Design Category		**D**	CBC Reference	ASCE 7-16 Reference
Site Class		**D**	Table 1613.5.6	Table 11.6-1
Latitude:		34.256 N	Table 1613.5.2	Table 20.3-1
Longitude:		-119.145 W		
Maximum Considered Earthquake (MCE) Ground Motion				
Short Period Spectral Reponse	S_S	**1.924 g**	Figure 1613.5	Figure 22-1
1 second Spectral Response	S_1	**0.719 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	1.70	Table 1613.5.3(2)	Table 11-4.2
	S_{MS}	1.924 g	$= F_a*S_S$	
	S_{M1}	1.222 g	$= F_v*S_1$	

FALSE

Design Earthquake Ground Motion			
Short Period Spectral Reponse	S_{DS}	**1.283 g**	$= 2/3*S_{MS}$
1 second Spectral Response	S_{D1}	**0.815 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)	0.64 sec	$= S_{D1}/S_{DS}$
Risk Category	III	Table 1604.5
Seismic Importance Factor	1.25	
F_{PGA}	1.10	
PGA_M	**0.94**	
Vertical Coefficient (C_V)	1.48	Table 11.9-1

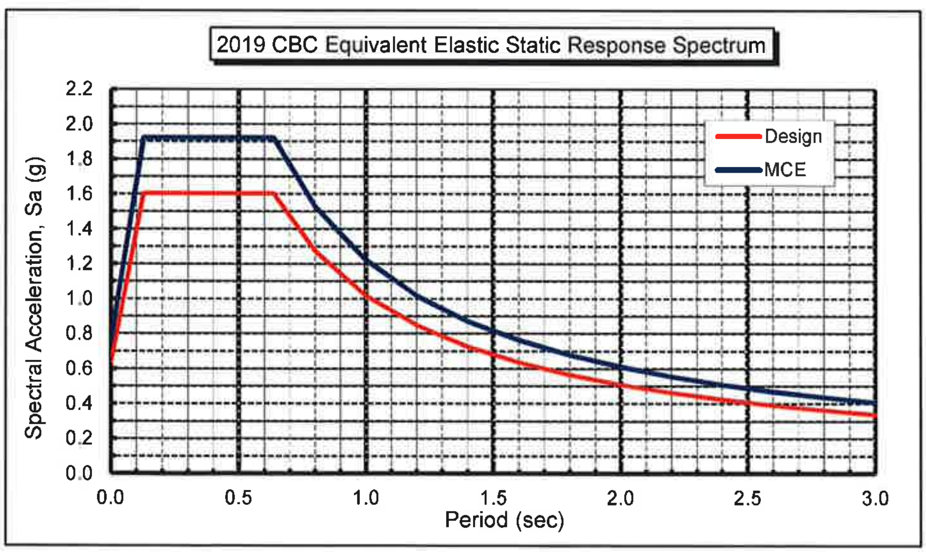


Table 11.5-1 Period T (sec)	Design Sa (g)
0.00	0.641
0.05	1.020
0.13	1.603
0.64	1.603
0.80	1.273
1.00	1.019
1.20	0.849
1.40	0.728
1.60	0.637
1.80	0.566
2.00	0.509
2.20	0.463
2.40	0.424
2.60	0.392
2.80	0.364
3.00	0.340

Rio Mesa HS Home Bleachers

Latitude, Longitude: 34.2556, -119.1448

Date	1/29/2020, 9:01:44 AM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.924	MCE_R ground motion. (for 0.2 second period)
S_1	0.719	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.924	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.283	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	0.851	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.936	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	1.924	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.181	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.505	Factored deterministic acceleration value. (0.2 second)
S1RT	0.719	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.811	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.862	Factored deterministic acceleration value. (1.0 second)
PGAd	1.011	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.882	Mapped value of the risk coefficient at short periods
C_{R1}	0.886	Mapped value of the risk coefficient at a period of 1 s

Table A-3 - 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	Max Rotated Probab. 2% in 50 year MCEr Spectrum	Max 84th Percentile Determ. MCE Spectrum	Determ. Lower Limit MCE Spectrum	Determ. MCE Spectrum	Site Specific MCE Ground Response	Site Specific MCE Spectrum Comparator	2019 CBC MCE Spectrum	Site Specific Design Spectrum	2019 CBC Design Spectrum
	(1) 2475-year (ASCE 21.2.1)	(2) 2475-year **(ASCE 21.2.1.1)**	(3) 1.5*Fa = 1.500 (ASCE 21.2.2)	(4) (3) * 1-Scaling (ASCE 21.2.2)	(5) Max (3),(4) (ASCE 21.2.2)	(6) Min (2),(5) (ASCE 21.2.3)	(6b) Max (6),1.5*(8) (ASCE 21.2.3)	(7)	(8) (ASCE 21.3)	(9) 2/3*(7)
0.00	0.843	0.817	1.145	1.145	1.145	0.817	0.817	0.770	0.545	0.513
0.05	1.098	1.065	1.230	1.230	1.230	1.065	1.065	1.079	0.710	0.719
0.10	1.354	1.314	1.615	1.615	1.615	1.314	1.314	1.387	0.876	0.925
0.15	1.584	1.537	1.948	1.948	1.948	1.537	1.537	1.696	1.025	1.131
0.20	1.814	1.760	2.232	2.232	2.232	1.760	1.760	1.924	1.173	1.283
0.30	2.131	2.116	2.674	2.674	2.674	2.116	2.116	1.924	1.411	1.283
0.40	2.137	2.122	2.851	2.851	2.851	2.122	2.122	1.924	1.415	1.283
0.50	2.142	2.223	2.819	2.819	2.819	2.223	2.223	1.924	1.482	1.283
0.75	1.828	1.900	2.470	2.470	2.470	1.900	1.900	1.924	1.267	1.283
1.00	1.514	1.743	2.144	2.144	2.144	1.743	1.743	1.798	1.162	1.198
1.50	1.167	1.344	1.565	1.565	1.565	1.344	1.344	1.198	0.896	0.799
2.00	0.820	0.980	1.196	1.196	1.196	0.980	0.980	0.899	0.654	0.599
3.00	-	-	-	-	-	-	-	-	-	-
4.00	-	-	-	-	-	-	-	-	-	-
5.00	-	-	-	-	-	-	-	-	-	-
8.00	-	-	-	-	-	-	-	-	-	-
10.00	-	-	-	-	-	-	-	-	-	-

C_{RS}:	0.882	
C_{R1}:	0.886	
Site Specific To:	0.201	$= 0.2*S_{D1}/S_{DS}$
Site Specific Ts:	1.007	$= S_{D1}/S_{DS}$

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.

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

Site Coefficients	
F_{PGA}	1.10
F_a	1.00
F_v	2.50

Mapped MCE Acceleration Values		
PGA	0.851	g
S_S	1.924	g
S_1	0.719	g

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

Vertical Coefficient (C_V)
1.48

Site-Specific Design Acceleration Values		
PGA_M	**0.843**	**g**
S_{DS}	**1.334**	**g**
S_{D1}	**1.344**	**g**

Site-Specific MCE_R, 5% damped, Spectral Response Acceleration Parameter		
S_{MS}	**2.001**	**g**
S_{M1}	**2.016**	**g**

1 g = 980.6 cm/sec² =32.2 ft/sec²
PSV (ft/sec) = 32.2(S_a)T/(2p)

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)	0.0	0.0	1.0	19.4	65	159	90	49	B	**7.2**		4
Simi-Santa Rosa	3.7	6.0	1.0	12.1	60	346	30	39	B	**6.8**		1
Ventura-Pitas Point	4.8	7.7	1.0	15.0	64	353	60	44	B	**6.9**		1
Oak Ridge (Offshore)	7.3	11.8	0.0	7.9	32	180	90	38	B	**6.9**		3
Red Mountain	10.7	17.3	0.0	14.1	56	2	90	101	B	**7.4**		2
Sisar	11.4	18.3	0.0	17.4	29	168	na	20	B'	**7.0**		
San Cayetano	12.5	20.1	0.0	16.0	42	3	90	42	B	**7.2**		6
Malibu Coast (Extension), alt 1	13.2	21.3	0.0	7.8	74	4	30	35	B'	**6.5**		
Malibu Coast (Extension), alt 2	13.2	21.3	0.0	16.6	74	4	30	35	B'	**6.9**		
Mission Ridge-Arroyo Parida-Santa Ana	13.8	22.2	0.0	7.6	70	176	90	69	B	**6.8**		0.4
North Channel	16.6	26.7	1.1	4.5	26	10	90	51	B	**6.7**		1
Channel Islands Thrust	17.2	27.8	5.0	12.3	20	354	90	59	B	**7.3**		1.5
Malibu Coast, alt 1	18.8	30.3	0.0	7.8	75	3	30	38	B	**6.6**		0.3
Malibu Coast, alt 2	18.8	30.3	0.0	16.6	74	3	30	38	B	**6.9**		0.3
Santa Ynez (East)	19.1	30.7	0.0	13.3	70	172	0	68	B	**7.2**		2
Anacapa-Dume, alt 1	19.4	31.2	0.0	15.5	45	354	60	51	B	**7.2**		3
Anacapa-Dume, alt 2	19.4	31.2	1.2	11.4	41	352	60	65	B	**7.2**		3
Channel Islands Western Deep Ramp	19.7	31.8	4.8	12.5	21	204	90	62	B'	**7.3**		
Pitas Point (Lower)-Montalvo	19.9	32.0	0.4	12.7	16	359	90	30	B	**7.3**		2.5
Santa Cruz Island	20.0	32.1	0.0	13.3	90	188	30	69	B	**7.1**		1
Pine Mtn	22.2	35.7	0.0	16.3	45	5	na	62	B'	**7.3**		
Santa Susana, alt 1	22.7	36.5	0.0	16.3	55	9	90	27	B	**6.8**		5
Santa Susana, alt 2	22.8	36.6	0.0	10.6	53	10	90	43	B'	**6.8**		
Shelf (Projection)	24.1	38.8	2.0	18.1	17	21	na	70	B'	**7.8**		
Northridge Hills	25.2	40.6	0.0	14.9	31	19	90	25	B'	**7.0**		
Del Valle	25.3	40.8	0.0	18.8	73	195	90	9	B'	**6.3**		
Pitas Point (Upper)	25.5	41.0	1.4	10.0	42	15	90	35	B	**6.8**		1
Holser, alt 1	25.6	41.3	0.0	18.6	58	187	90	20	B	**6.7**		0.4
Holser, alt 2	25.6	41.3	0.0	18.5	58	182	90	17	B'	**6.7**		
Northridge	27.1	43.6	7.4	16.8	35	201	90	33	B	**6.8**		1.5
Santa Cruz Catalina Ridge	27.4	44.2	0.0	11.0	90	38	na	137	B'	**7.3**		
Santa Monica Bay	29.4	47.4	2.3	18.0	20	44	na	17	B'	**7.0**		
San Pedro Basin	29.4	47.4	0.8	12.3	88	51	na	69	B'	**7.0**		
Oak Ridge (Offshore), west extension	30.4	48.8	0.0	3.1	67	195	na	28	B'	**6.1**		
Big Pine (Central)	31.0	50.0	0.0	6.6	76	167	na	23	B'	**6.3**		
Big Pine (West)	32.5	52.3	0.0	11.0	50	2	na	18	B'	**6.5**		
Santa Ynez (West)	32.6	52.5	0.0	9.2	70	182	0	63	B	**6.9**		2
San Gabriel	32.9	53.0	0.0	14.7	61	39	180	71	B	**7.3**		1
Big Pine (East)	33.1	53.3	0.0	14.3	73	338	na	23	B'	**6.6**		
Compton	34.5	55.5	5.2	15.6	20	34	90	65	B'	**7.5**		

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

Based on Site Coordinates of 34.2556 Latitude, -119.1448 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/Seismic-Induced Settlement Analyses Calculations
Liquefaction Analysis Curve Printouts

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: **Rio Mesa High School Home Bleachers**
Job No: **303280-002**
Date: **2/20/2020**
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: **0.94** 0.84
MSF: 1.11
GWT: **52.0** feet
Calc GWT: **25.0** 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

Threshold Acceler., g: **1.48**

Total (ft) Liquefied Thickness: **0**
Total (in.) Induced Subsidence: **0.4**

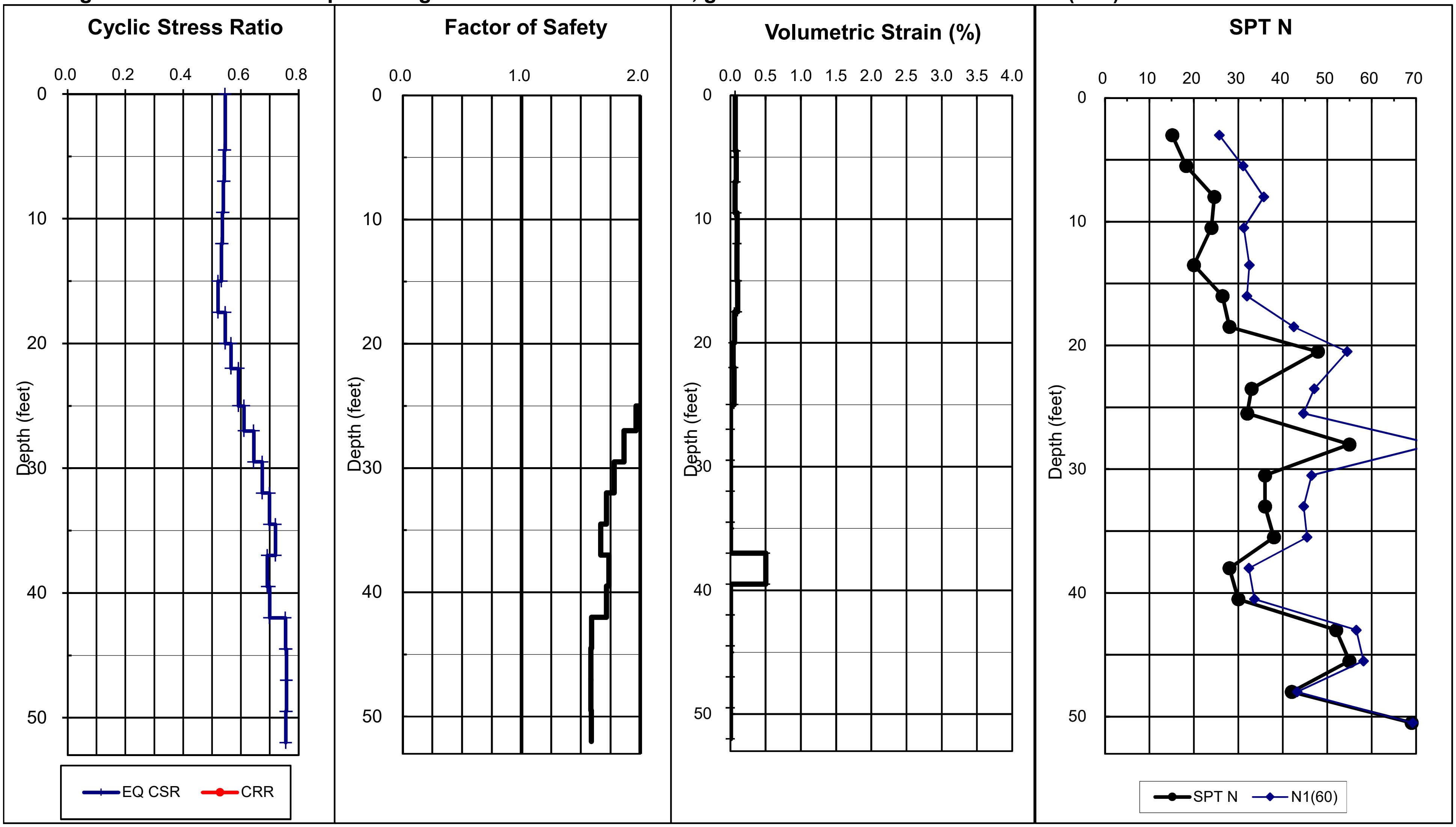
Required SF: **1.30**
Minimum Calculated SF: **1.58**

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																	
4.5	24	**15**	1	125	20	3.0	6.0	0.188	0.188	0.99	1.70	0.75	1.00	25.7	61	5.7	31.4	1.00	1.200	0.545	**Non-Liq.**	5.7	31.4	0.07	**0.04**
7.0	29	**18**	1	125	5	5.5	8.5	0.344	0.344	0.99	1.70	0.75	1.00	31.1	67	0.0	31.1	1.00	1.200	0.542	**Non-Liq.**	0.0	31.1	0.08	**0.02**
9.5	39	25	1	125	5	8.0	11.0	0.500	0.500	0.98	1.45	0.75	1.00	35.7	71	0.0	35.7	1.00	1.200	0.539	**Non-Liq.**	0.0	35.7	0.07	**0.02**
12.0	38	24	1	125	5	10.5	13.5	0.656	0.656	0.98	1.27	0.77	1.00	31.2	67	0.0	31.2	1.00	1.200	0.536	**Non-Liq.**	0.0	31.2	0.10	**0.03**
15.0	0	20	1	125	5	13.5	16.5	0.844	0.844	0.97	1.12	0.84	1.30	32.5	68	0.0	32.5	1.00	1.200	0.533	**Non-Liq.**	0.0	32.5	0.09	**0.03**
17.5	42	26	1	125	5	16.0	19.0	1.000	1.000	0.97	1.03	0.88	1.00	31.9	68	0.0	31.9	1.02	1.200	0.521	**Non-Liq.**	0.0	31.9	0.10	**0.03**
20.0	0	28	1	125	5	18.5	21.5	1.156	1.156	0.96	0.96	0.92	1.30	42.5	78	0.0	42.5	0.97	1.200	0.546	**Non-Liq.**	0.0	42.5	0.06	**0.02**
22.0	76	48	1	125	5	20.5	23.5	1.281	1.281	0.96	0.91	0.94	1.00	54.5	88	0.0	54.5	0.93	1.200	0.566	**Non-Liq.**	0.0	54.5	0.04	**0.01**
25.0	0	33	1	125	5	23.5	26.5	1.469	1.469	0.95	0.85	0.97	1.30	47.1	82	0.0	47.1	0.88	1.200	0.592	**Non-Liq.**	0.0	47.1	0.05	**0.02**
27.0	0	32	1	125	5	25.5	28.5	1.594	1.594	0.94	0.81	0.99	1.30	44.6	80	0.0	44.6	0.85	1.200	0.611	**1.96**	0.0	44.6	0.00	**0.00**
29.5	0	55	1	125	5	28.0	31.0	1.750	1.750	0.93	0.78	1.00	1.30	74.1	100	0.0	74.1	0.84	1.200	0.644	**1.86**	0.0	74.1	0.00	**0.00**
32.0	0	36	1	125	5	30.5	33.5	1.906	1.906	0.92	0.74	1.00	1.30	46.5	81	0.0	46.5	0.82	1.200	0.674	**1.78**	0.0	46.5	0.00	**0.00**
34.5	0	36	1	125	5	33.0	36.0	2.063	2.063	0.90	0.72	1.00	1.30	44.7	80	0.0	44.7	0.81	1.200	0.699	**1.72**	0.0	44.7	0.00	**0.00**
37.0	0	38	1	125	5	35.5	38.5	2.219	2.219	0.89	0.69	1.00	1.30	45.5	81	0.0	45.5	0.79	1.200	0.720	**1.67**	0.0	45.5	0.00	**0.00**
39.5	0	28	1	125	5	38.0	41.0	2.375	2.375	0.87	0.67	1.00	1.30	32.4	68	0.0	32.4	0.83	1.200	0.691	**1.74**	0.0	32.4	0.50	**0.15**
42.0	0	30	1	125	5	40.5	43.5	2.531	2.531	0.85	0.65	1.00	1.30	33.6	69	0.0	33.6	0.82	1.200	0.699	**1.72**	0.0	33.6	0.00	**0.00**
44.5	0	52	1	125	5	43.0	46.0	2.688	2.688	0.82	0.63	1.00	1.30	56.6	90	0.0	56.6	0.76	1.200	0.754	**1.59**	0.0	56.6	0.00	**0.00**
47.0		55	1	125	5	45.5	48.5	2.844	2.844	0.80	0.61	1.00	1.30	58.1	91	0.0	58.2	0.75	1.200	0.758	**1.58**	0.0	58.2	0.00	**0.00**
49.5		42	1	125	5	48.0	51.0	3.000	3.000	0.77	0.59	1.00	1.30	43.2	79	0.0	43.2	0.74	1.200	0.758	**1.58**	0.0	43.2	0.00	**0.00**
52.0		69	1	125	5	50.5	53.5	3.156	3.156	0.75	0.58	1.00	1.30	69.2	99	0.0	69.2	0.73	1.200	0.755	**1.59**	0.0	69.2	0.00	**0.00**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Rio Mesa High School Home Bleachers   Project No: 303280-002   1996/1998 NCEER Method

Boring: B-1   Earthquake Magnitude: 7.2   PGA, g: 0.94   Calc GWT (feet): 25



Total Thickness of Liquefiable Layers: 0.0 feet

Estimated Total Ground Subsidence: 0.4 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: Rio Mesa High School Home Bleachers
Job No: 303280-002
Date: 2/20/2020
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: 0.94 0.84
MSF: 1.11
GWT: 52.0 feet
Calc GWT: 52.0 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

Threshold Acceler., g: #N/A

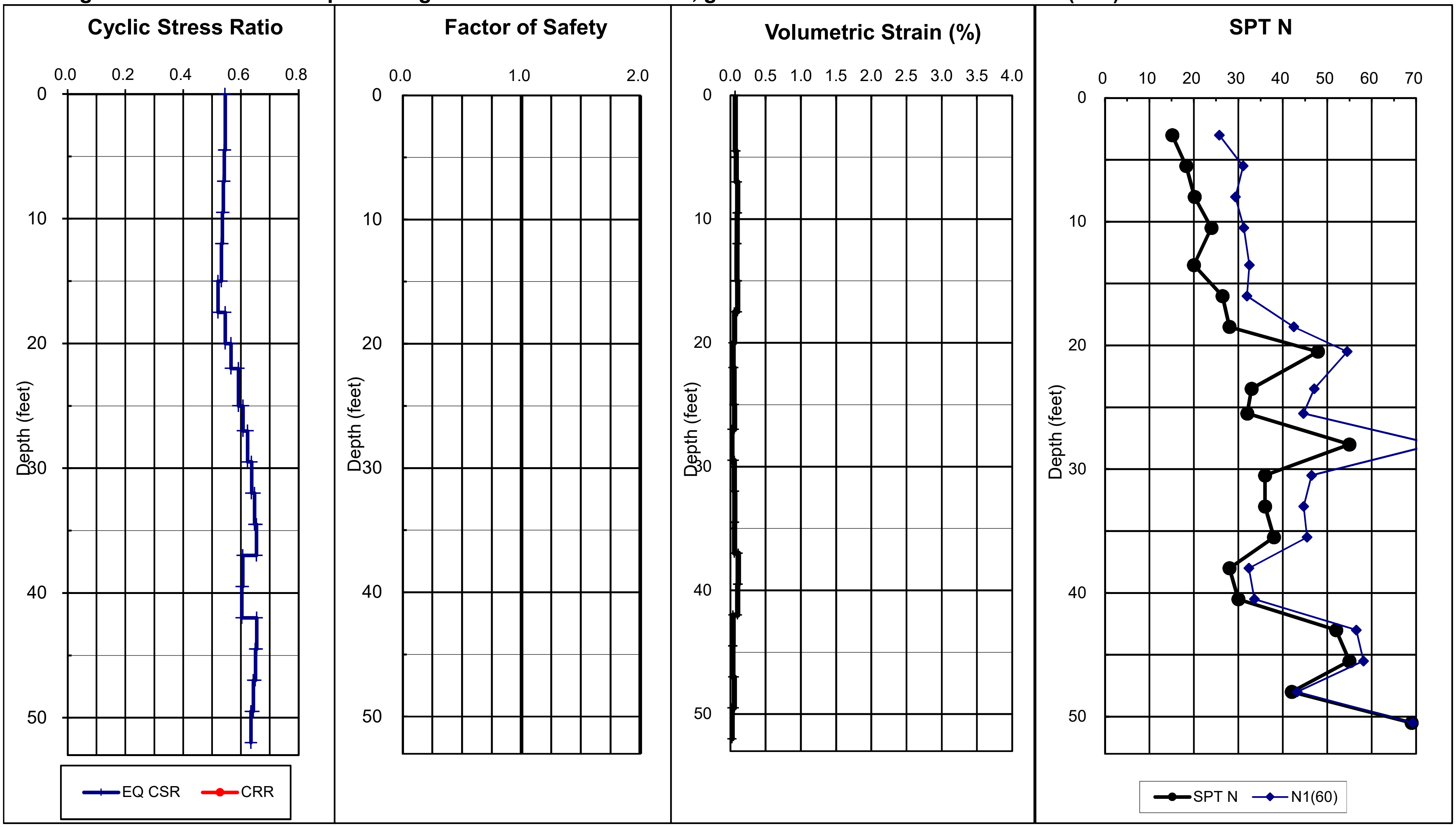
Total (ft) Liquefied Thickness: 0
Total (in.) Induced Subsidence: 0.4
Required SF: 1.30
Minimum Calculated SF: #N/A

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																	
4.5	24	**15**	1	125	20	3.0	6.0	0.188	0.188	0.99	1.70	0.75	1.00	25.7	61	5.7	31.4	1.00	1.200	0.545	**Non-Liq.**	5.7	31.4	0.07	**0.04**
7.0	29	**18**	1	125	5	5.5	8.5	0.344	0.344	0.99	1.70	0.75	1.00	31.1	67	0.0	31.1	1.00	1.200	0.542	**Non-Liq.**	0.0	31.1	0.08	**0.02**
9.5	32	20	1	125	5	8.0	11.0	0.500	0.500	0.98	1.45	0.75	1.00	29.3	65	0.0	29.3	1.00	0.390	0.539	**Non-Liq.**	0.0	29.3	0.10	**0.03**
12.0	38	24	1	125	5	10.5	13.5	0.656	0.656	0.98	1.27	0.77	1.00	31.2	67	0.0	31.2	1.00	1.200	0.536	**Non-Liq.**	0.0	31.2	0.10	**0.03**
15.0	0	20	1	125	5	13.5	16.5	0.844	0.844	0.97	1.12	0.84	1.30	32.5	68	0.0	32.5	1.00	1.200	0.533	**Non-Liq.**	0.0	32.5	0.09	**0.03**
17.5	42	26	1	125	5	16.0	19.0	1.000	1.000	0.97	1.03	0.88	1.00	31.9	68	0.0	31.9	1.02	1.200	0.521	**Non-Liq.**	0.0	31.9	0.10	**0.03**
20.0	0	28	1	125	5	18.5	21.5	1.156	1.156	0.96	0.96	0.92	1.30	42.5	78	0.0	42.5	0.97	1.200	0.546	**Non-Liq.**	0.0	42.5	0.06	**0.02**
22.0	76	48	1	125	5	20.5	23.5	1.281	1.281	0.96	0.91	0.94	1.00	54.5	88	0.0	54.5	0.93	1.200	0.566	**Non-Liq.**	0.0	54.5	0.04	**0.01**
25.0	0	33	1	125	5	23.5	26.5	1.469	1.469	0.95	0.85	0.97	1.30	47.1	82	0.0	47.1	0.88	1.200	0.592	**Non-Liq.**	0.0	47.1	0.05	**0.02**
27.0	0	32	1	125	5	25.5	28.5	1.594	1.594	0.94	0.81	0.99	1.30	44.6	80	0.0	44.6	0.85	1.200	0.607	**Non-Liq.**	0.0	44.6	0.06	**0.01**
29.5	0	55	1	125	5	28.0	31.0	1.750	1.750	0.93	0.78	1.00	1.30	74.1	100	0.0	74.1	0.82	1.200	0.624	**Non-Liq.**	0.0	74.1	0.02	**0.01**
32.0	0	36	1	125	5	30.5	33.5	1.906	1.906	0.92	0.74	1.00	1.30	46.5	81	0.0	46.5	0.79	1.200	0.637	**Non-Liq.**	0.0	46.5	0.06	**0.02**
34.5	0	36	1	125	5	33.0	36.0	2.063	2.063	0.90	0.72	1.00	1.30	44.7	80	0.0	44.7	0.77	1.200	0.647	**Non-Liq.**	0.0	44.7	0.06	**0.02**
37.0	0	38	1	125	5	35.5	38.5	2.219	2.219	0.89	0.69	1.00	1.30	45.5	81	0.0	45.5	0.74	1.200	0.654	**Non-Liq.**	0.0	45.5	0.06	**0.02**
39.5	0	28	1	125	5	38.0	41.0	2.375	2.375	0.87	0.67	1.00	1.30	32.4	68	0.0	32.4	0.78	1.200	0.606	**Non-Liq.**	0.0	32.4	0.11	**0.03**
42.0	0	30	1	125	5	40.5	43.5	2.531	2.531	0.85	0.65	1.00	1.30	33.6	69	0.0	33.6	0.77	1.200	0.603	**Non-Liq.**	0.0	33.6	0.10	**0.03**
44.5	0	52	1	125	5	43.0	46.0	2.688	2.688	0.82	0.63	1.00	1.30	56.6	90	0.0	56.6	0.69	1.200	0.655	**Non-Liq.**	0.0	56.6	0.04	**0.01**
47.0		55	1	125	5	45.5	48.5	2.844	2.844	0.80	0.61	1.00	1.30	58.1	91	0.0	58.2	0.67	1.200	0.650	**Non-Liq.**	0.0	58.2	0.03	**0.01**
49.5		42	1	125	5	48.0	51.0	3.000	3.000	0.77	0.59	1.00	1.30	43.2	79	0.0	43.2	0.66	1.200	0.643	**Non-Liq.**	0.0	43.2	0.06	**0.02**
52.0		69	1	125	5	50.5	53.5	3.156	3.156	0.75	0.58	1.00	1.30	69.2	99	0.0	69.2	0.65	1.200	0.635	**Non-Liq.**	0.0	69.2	0.02	**0.01**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED SUBSIDENCE

Rio Mesa High School Home Bleachers **Project No: 303280-002** 1996/1998 NCEER Method

Boring: B-1 **Earthquake Magnitude: 7.2** **PGA, g: 0.94** **Calc GWT (feet): 52**



Total Thickness of Liquefiable Layers: 0.0 feet **Estimated Total Ground Subsidence: 0.4 inches**

CPT-LIQUEFY.XLS - A SPREADSHEET FOR EMPIRICAL ESTIMATION OF LIQUEFACTION POTENTIAL USING CPT DATA

Developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Project: Rio Mesa High School Bleachers
Job No: 303280-002
Date: 2/20/2020
Sounding: CPT-2

Liquefaction Analysis using 1998 NCEER (Robertson & Wride) method
Settlement Analysis using Tokimatsu & Seed (1987), clean sand Qc1n/N1(60) ratio =5

EARTHQUAKE INFORMATION:
Magnitude: 7.2 | 7.5
PGA, g: 0.94 | 0.85
MSF: 1.11
GWT, feet: 55.0
Calc GWT, feet: 25.0

Plot: 2
Method Used: 1 | 1998 NCEER (Robertson & Wride)
Averaging Increment: 3 | 0.15 m
Induced CSR (M=7.5) $= 0.65*PGA*(po/p'o)*rd/MSF$
Clean Sand Qc1n $= C_Q*K_C*K_H*Qc$
SF $= CRR_{7.5}*K\sigma/CSR$

Ignore 1st/last increment into sand/silt soils: 1 yes
Ignore/remediate upper: 1.0 m
Unit Weight of unsaturated soils: 115 pcf
Unit Weight of saturated soils: 130 pcf
Limiting Ic for liquefiable soils: 2.60
Limiting Ic for K_H: 2.6

Use Moss @ P_L: 15%
Use Tokimatsu & Seed (0) or Ishihara &Yoshmine (1): 0
Required SF: 1.50
Min SF of Liquefiable Layers: 0.36
Avg SF of Liquefiable Layers: 0.50
Max $\Delta N_{1(60)}$ - post liquefied: 5.5
Max $\Delta N_{1(60)}$ - non liquefied: 5.0

Total Liquefied Thickness (feet): 2.0
Total Induced Subsidence (inches): 0.3

SETTLEMENT OF DRY SANDS
Qc1n / N1(60) Ratio for clean sand: 5
$p = 0.67*po$
$\tau_{av} = 0.65*PGA*po*rd$
$G_{max} = 447*N_{1(60)CS}^{(1/3)}*p^{0.5}$
$a = 0.0389*(p/1)+0.124$
$b = 6400*(p/1)^{(-0.6)}$
$\gamma = [1+a*EXP(b*\tau_{av}/G_{max})]/[(1+a)*\tau_{av}/G_{max}]$
$E_{15} = \gamma*(N_{1(60)CS}/20)^{-1.2}$
$Nc = (MAG-4)^{2.17}$
$E_{nc} = (Nc/15)^{0.45}*E15$
$S = 2*H*E_{nc}$
Nc = 12.5

Depth (feet)	(m)	Tip Qc (tsf)	Friction Fs (tsf)	Friction Ratio Rf %	qc MPa	Total Unit Wt. (pcf)	Total Stress po (tsf)	Eff. Stress p'o (tsf)	rd	F %	n	Max 1.70 Cq	Q	Moss qc1 MPa	Moss Δqc MPa	Moss qc_{1mod} MPa	Moss eff K_C	Qc1n	Ic	Overide	Liquef. Suscept. (0 or 1)	Rel. Dens. Dr (%)	K_C	K_H	Clean Sand Qc1n	1.0 Kσ	CRR	Induced M=7.5 CSR	Liquefac. Safety Factor	Qc1n $N_{1(60)}$ Ratio	Equiv. $N_{1(60)}$	FC Adj. $\Delta N_{1(60)}$	Equiv. $N_{1(60)cs}$	Volumetric Strain (%)	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
0.49	0.15	29.10	0.40	1.36	2.79	115	0.028	0.028	1.000	1.36	0.68	1.70	46.72	4.74	0.93	5.66		46.76	2.25		0			1.00		1.00		0.367	Non-Liq.	4.6	10.2			0.00	0.019						
0.98	0.30	101.66	0.33	0.33	9.73	115	0.057	0.057	1.000	0.33	0.50	1.70	163.25	16.55	0.00	16.55		163.34	1.46		0			1.00		1.00		0.367	Non-Liq.	6.1	26.6			0.00	0.038						
1.48	0.45	215.01	1.12	0.52	20.59	115	0.085	0.085	0.999	0.52	0.50	1.70	345.34	35.00	0.02	35.03		345.47	1.32		0			1.00		1.00		0.367	Non-Liq.	6.4	53.9			0.00	0.057						
1.97	0.60	301.85	1.78	0.59	28.91	115	0.113	0.113	0.997	0.59	0.50	1.70	484.84	49.14	0.10	49.24		485.02	1.26		0			1.00		1.00		0.366	Non-Liq.	6.5	74.3			0.00	0.076						
2.46	0.75	355.53	2.24	0.63	34.05	115	0.141	0.141	0.996	0.63	0.50	1.70	571.03	57.88	0.14	58.02		571.26	1.25		0			1.00		1.00		0.366	Non-Liq.	6.6	87.1			0.00	0.095						
2.95	0.90	221.02	2.81	1.27	21.17	115	0.170	0.170	0.995	1.27	0.50	1.70	354.87	35.98	0.83	36.81		355.14	1.61		0			1.00		1.00		0.365	Non-Liq.	5.8	60.8			0.00	0.114						
3.44	1.05	91.96	2.13	2.31	8.81	115	0.198	0.198	0.994	2.32	0.62	1.70	147.44	14.95	1.95	16.90	1.13	147.76	2.05		1	93	1.37	1.00	202.8	1.00	Infin.	0.365	Non-Liq.	5.0	29.7	5.0	34.7	0.06	0.133	531	0.080	5.8E-04	3.0E-04	2.8E-04	0.003
3.94	1.20	62.05	0.83	1.33	5.94	115	0.226	0.226	0.993	1.34	0.61	1.70	99.34	10.10	0.89	11.00	1.09	99.71	2.00		1	77	1.29	1.00	129.0	1.00	0.280	0.364	Non-Liq.	5.1	19.6	5.0	24.6	0.13	0.152	506	0.092	9.1E-04	7.1E-04	6.6E-04	0.008
4.43	1.35	76.41	0.49	0.64	7.32	115	0.255	0.255	0.992	0.64	0.52	1.70	122.36	12.44	0.15	12.59	1.01	122.77	1.72		1	85	1.05	1.00	129.3	1.00	0.281	0.364	Non-Liq.	5.6	21.8	4.0	25.9	0.12	0.171	546	0.103	8.8E-04	6.4E-04	5.9E-04	0.007
4.92	1.50	103.62	0.63	0.61	9.92	115	0.283	0.283	0.990	0.61	0.50	1.70	166.05	16.87	0.12	16.99	1.01	166.50	1.61		1	98	1.00	1.00	166.5	1.00	Infin.	0.364	Non-Liq.	5.9	28.4	4.9	33.3	0.07	0.190	626	0.114	6.6E-04	3.6E-04	3.3E-04	0.004
5.41	1.65	178.97	1.42	0.79	17.14	115	0.311	0.311	0.989	0.79	0.50	1.70	287.07	27.66	0.32	27.98	1.01	287.57	1.51		1	100	1.00	1.00	287.6	1.00	Infin.	0.363	Non-Liq.	6.0	47.6	5.0	52.6	0.02	0.209	765	0.125	4.3E-04	1.3E-04	1.2E-04	0.001
5.91	1.80	142.45	1.61	1.13	13.64	115	0.340	0.340	0.988	1.13	0.52	1.70	228.35	20.59	0.67	21.27	1.03	228.89	1.69		1	100	1.03	1.00	236.0	1.00	Infin.	0.363	Non-Liq.	5.7	40.2	5.0	45.2	0.03	0.228	760	0.137	5.1E-04	1.9E-04	1.7E-04	0.002
6.40	1.95	137.32	1.09	0.79	13.15	115	0.368	0.368	0.987	0.79	0.50	1.70	219.53	20.39	0.31	20.70	1.02	220.12	1.59		1	100	1.00	1.00	220.1	1.00	Infin.	0.362	Non-Liq.	5.9	37.4	5.0	42.4	0.04	0.246	774	0.148	5.5E-04	2.2E-04	2.1E-04	0.002
6.89	2.10	155.81	1.72	1.10	14.92	115	0.396	0.396	0.986	1.10	0.51	1.65	242.06	21.20	0.65	21.85	1.03	242.68	1.67		1	100	1.01	1.00	246.2	1.00	Infin.	0.362	Non-Liq.	5.7	42.3	5.0	47.3	0.03	0.265	833	0.159	5.1E-04	1.8E-04	1.7E-04	0.002
7.38	2.25	135.08	2.49	1.84	12.94	115	0.424	0.424	0.985	1.85	0.57	1.69	215.16	17.13	1.44	18.57	1.08	215.84	1.87		1	100	1.16	1.00	251.0	1.00	Infin.	0.361	Non-Liq.	5.3	40.5	5.0	45.5	0.04	0.284	851	0.170	5.4E-04	2.0E-04	1.9E-04	0.002
7.87	2.40	109.17	1.71	1.57	10.45	115	0.453	0.453	0.984	1.57	0.58	1.64	168.05	14.01	1.14	15.15	1.08	168.75	1.89		1	99	1.18	1.00	198.4	1.00	Infin.	0.361	Non-Liq.	5.3	31.8	5.0	36.8	0.06	0.303	819	0.181	6.8E-04	3.3E-04	3.0E-04	0.004
8.37	2.55	113.57	0.86	0.75	10.88	115	0.481	0.481	0.983	0.76	0.51	1.50	160.01	15.39	0.27	15.67	1.02	160.69	1.68		1	97	1.02	1.00	164.2	1.00	Infin.	0.361	Non-Liq.	5.7	28.1	4.7	32.8	0.08	0.322	813	0.193	7.8E-04	4.3E-04	3.9E-04	0.005
8.86	2.70	125.19	0.93	0.74	11.99	115	0.509	0.509	0.982	0.75	0.50	1.45	170.31	16.46	0.26	16.72	1.02	171.01	1.65		1	99	1.00	1.00	171.8	1.00	Infin.	0.360	Non-Liq.	5.8	29.7	4.7	34.4	0.07	0.341	849	0.204	7.5E-04	3.9E-04	3.6E-04	0.004
9.35	2.85	139.56	1.15	0.83	13.36	115	0.538	0.538	0.981	0.83	0.51	1.41	184.98	17.61	0.35	17.96	1.02	185.69	1.66		1	100	1.01	1.00	187.1	1.00	Infin.	0.360	Non-Liq.	5.8	32.3	5.0	37.3	0.06	0.360	896	0.215	7.0E-04	3.3E-04	3.1E-04	0.004
9.84	3.00	126.82	1.23	0.97	12.14	115	0.566	0.566	0.979	0.97	0.53	1.39	166.37	15.53	0.50	16.04	1.03	167.11	1.74		1	98	1.06	1.00	177.7	1.00	Infin.	0.360	Non-Liq.	5.6	29.9	5.0	34.9	0.07	0.379	899	0.226	7.6E-04	3.9E-04	3.6E-04	0.004
10.33	3.15	130.94	1.04	0.80	12.54	115	0.594	0.594	0.978	0.80	0.51	1.34	165.65	15.96	0.32	16.28	1.02	166.40	1.68		1	98	1.03	1.00	170.6	1.00	Infin.	0.359	Non-Liq.	5.7	29.2	5.0	34.1	0.08	0.398	915	0.237	7.9E-04	4.2E-04	3.8E-04	0.005
10.83	3.30	218.95	1.00	0.46	20.97	115	0.623	0.623	0.977	0.46	0.50	1.30	269.01	26.79	0.00	26.79	1.00	269.78	1.36		1	100	1.00	1.00	269.8	1.00	Infin.	0.359	Non-Liq.	6.3	42.6	5.0	47.6	0.04	0.417	1,046	0.248	5.9E-04	2.1E-04	1.9E-04	0.002
11.32	3.45	246.56	1.31	0.53	23.61	115	0.651	0.651	0.976	0.53	0.50	1.27	296.34	29.04	0.03	29.08	1.00	297.13	1.38		1	100	1.00	1.00	297.1	1.00	Infin.	0.358	Non-Liq.	6.3	47.1	5.0	52.1	0.03	0.436	1,103	0.259	5.5E-04	1.7E-04	1.6E-04	0.002
11.81	3.60	273.30	1.70	0.62	26.17	115	0.679	0.679	0.975	0.62	0.50	1.25	321.61	31.15	0.13	31.28	1.00	322.41	1.40		1	100	1.00	1.00	322.4	1.00	Infin.	0.358	Non-Liq.	6.3	51.5	5.0	56.5	0.03	0.455	1,157	0.270	5.2E-04	1.5E-04	1.4E-04	0.002
12.30	3.75	312.17	2.13	0.68	29.89	115	0.707	0.707	0.974	0.68	0.50	1.22	360.02	34.69	0.19	34.88	1.01	360.84	1.40		1	100	1.00	1.00	360.8	1.00	Infin.	0.358	Non-Liq.	6.3	57.6	5.0	62.6	0.02	0.474	1,222	0.281	4.9E-04	1.2E-04	1.1E-04	0.001
12.80	3.90	316.44	2.36	0.75	30.30	115	0.736	0.736	0.973	0.75	0.50	1.20	357.83	34.48	0.26	34.74	1.01	358.66	1.43		1	100	1.00	1.00	358.7	1.00	Infin.	0.357	Non-Liq.	6.2	57.8	5.0	62.8	0.02	0.493	1,248	0.292	4.9E-04	1.2E-04	1.1E-04	0.001
13.29	4.05	403.23	2.58	0.64	38.61	115	0.764	0.764	0.972	0.64	0.50	1.18	447.64	43.42	0.15	43.57	1.00	448.49	1.31		1	100	1.00	1.00	448.5	1.00	Infin.	0.357	Non-Liq.	6.4	69.8	5.0	74.8	0.02	0.512	1,347	0.303	4.4E-04	9.0E-05	8.3E-05	0.001
13.78	4.20	320.39	2.88	0.90	30.68	115	0.792	0.792	0.971	0.90	0.50	1.16	349.06	33.75	0.43	34.17	1.01	349.93	1.50		1	100	1.00	1.00	349.9	1.00	Infin.	0.356	Non-Liq.	6.1	57.7	5.0	62.7	0.02	0.531	1,294	0.313	5.1E-04	1.3E-04	1.2E-04	0.001
14.27	4.35	281.28	2.36	0.84	26.94	115	0.821	0.821	0.970	0.84	0.50	1.14	301.00	29.42	0.36	29.79	1.01	301.88	1.52		1	100	1.00	1.00	301.9	1.00	Infin.	0.356	Non-Liq.	6.0	50.1	5.0	55.1	0.03	0.550	1,261	0.324	5.7E-04	1.7E-04	1.6E-04	0.002
14.76	4.50	351.34	1.96	0.56	33.64	115	0.849	0.849	0.969	0.56	0.50	1.12	369.83	36.67	0.06	36.73	1.00	370.73	1.32		1	100	1.00	1.00	370.7	1.00	Infin.	0.356	Non-Liq.	6.4	57.9	5.0	62.9	0.02	0.569	1,340	0.335	5.2E-04	1.3E-04	1.2E-04	0.001
15.26	4.65	467.81	2.79	0.60	44.80	115	0.877	0.877	0.968	0.60	0.50	1.10	484.69	47.92	0.10	48.03	1.00	485.60	1.27		1	100	1.00	1.00	485.6	1.00	Infin.	0.355	Non-Liq.	5.5	87.8	5.0	92.8	0.01	0.588	1,551	0.346	4.0E-04	6.3E-05	5.8E-05	0.001
15.75	4.80	320.30	3.03	0.95	30.67	115	0.906	0.906	0.967	0.95	0.50	1.08	326.32	32.25	0.48	32.73	1.01	327.24	1.53		1	100	1.00	1.00	327.2	1.00	Infin.	0.355	Non-Liq.	6.0	54.6	5.0	59.6	0.03	0.607	1,360	0.357	5.5E-04	1.5E-04	1.4E-04	0.002
16.24	4.95	292.71	2.49	0.85	28.03	115	0.934	0.934	0.966	0.85	0.50	1.06	293.54	29.26	0.37	29.63	1.01	294.48	1.53		1	100	1.00	1.00	294.5	1.00	Infin.	0.355	Non-Liq.	6.0	49.0	5.0	54.0	0.03	0.626	1,336	0.367	6.0E-04	1.8E-04	1.7E-04	0.002
16.73	5.10	409.29	2.62	0.64	39.19	115	0.962	0.962	0.965	0.64	0.50	1.05	404.72	40.55	0.15	40.70	1.00	405.68	1.34		1	100	1.00	1.00	405.7	1.00	Infin.	0.354	Non-Liq.	6.4	63.7	5.0	68.7	0.02	0.645	1,470	0.378	5.1E-04	1.2E-04	1.1E-04	0.001
17.22	5.25	499.33	2.80	0.56	47.82	115	0.990	0.990	0.964	0.56	0.50	1.03	486.83	48.98	0.06	49.04	1.00	487.80	1.25		1	100	1.00	1.00	487.8	1.00	Infin.	0.354	Non-Liq.	5.5	88.2	5.0	93.2	0.01	0.664	1,651	0.389	4.2E-04	6.6E-05	6.0E-05	0.001
17.72	5.40	482.48	2.53	0.52	46.20	115	1.019	1.019	0.962	0.53	0.50	1.02	463.77	46.87	0.03	46.89	1.00	464.75	1.24		1	100	1.00	1.00	464.7	1.00	Infin.	0.353	Non-Liq.	5.5	84.0	5.0	89.0	0.01	0.683	1,649	0.399	4.3E-04	7.2E-05	6.6E-05	0.001
18.21	5.55	497.12	2.55	0.51	47.60	115	1.047	1.047	0.961	0.51	0.50	1.01	471.33	47.79	0.01	47.81	1.00	472.33	1.23		1	100	1.00	1.00	472.3	1.00	Infin.	0.353	Non-Liq.	5.5	85.4	5.0	90.4	0.01	0.701	1,680	0.410	4.3E-04	7.1E-05	6.5E-05	0.001
18.70	5.70	499.04	3.35	0.67	47.79	115	1.075	1.075	0.960	0.67	0.50	0.99	466.86	47.53	0.18	47.71	1.00	467.87	1.32		1	100	1.00	1.00	467.9	0.99	Infin.	0.352	Non-Liq.	6.4	72.9	5.0	77.9	0.02	0.720	1,621	0.421	4.8E-04	9.5E-05	8.7E-05	0.001
19.19	5.85	507.41	3.60	0.71	48.59	115	1.104	1.104	0.959	0.71	0.50	0.98	468.56	47.92	0.22	48.14	1.00	469.59	1.34		1	100	1.00	1.00	469.6	0.98	Infin.	0.352	Non-Liq.	6.4	73.6	5.0	78.6	0.02	0.739	1,647	0.431	4.9E-04	9.4E-05	8.6E-05	0.001
19.69	6.00	467.05	3.38	0.72	44.72	115	1.132	1.132	0.958	0.73	0.50	0.97	425.76	43.73	0.24	43.97	1.01	426.79	1.37		1	100	1.00	1.00	426.8	0.97	Infin.	0.352	Non-Liq.	6.3	67.6	5.0	72.6	0.02	0.758	1,624	0.442	5.2E-04	1.1E-04	1.0E-04	0.001
20.18	6.15	493.67	3.89	0.79	47.27	115	1.160	1.160	0.956	0.79	0.50	0.95	444.54	45.91	0.31	46.22	1.01	445.59	1.39		1	100	1.00	1.00	445.6	0.96	Infin.	0.351	Non-Liq.	6.3	70.9	5.0	75.9	0.02	0.777	1,669	0.452	5.1E-04	1.0E-04	9.4E-05	0.001
20.67	6.30	350.65	3.99	1.14	33.58	115	1.188	1.188	0.955	1.14	0.50	0.94	311.65	32.45	0.68	33.12	1.02	312.71	1.61		1	100	1.00	1.00	312.7	0.95	Infin.	0.351	Non-Liq.	5.9	53.5	5.0	58.5	0.03	0.796	1,548	0.462	6.2E-04	1.7E-04	1.6E-04	0.002
21.16	6.45	358.36	3.40	0.95	34.32	115	1.217	1.217	0.954	0.95	0.50	0.93	314.77	32.84	0.48	33.32	1.01	315.85	1.54		1	100	1.00	1.00	315.8	0.95	Infin.	0.350	Non-Liq.	6.0	52.9	5.0	57.9	0.03	0.815	1,561	0.473	6.3E-04	1.8E-04	1.6E-04	0.002
21.65	6.60	365.78	3.39	0.93	35.03	115	1.245	1.245	0.952	0.93	0.50	0.92	317.62	33.27	0.45	33.72	1.01	318.70	1.53		1	100	1.00	1.00	318.7	0.94	Infin.	0.350	Non-Liq.	6.0	53.1	5.0	58.1	0.03	0.834	1,582	0.483	6.3E-04	1.7E-04	1.6E-04	0.002
22.15	6.75	438.62	4.15	0.95	42.00	130	1.277	1.277	0.951	0.95	0.50	0.91	376.24	39.68	0.47	40.15	1.01	377.34	1.49		1	100	1.00	1.00	377.3	0.93	Infin.	0.349	Non-Liq.	6.1	62.2	5.0	67.2	0.02	0.856	1,681	0.495	5.7E-04	1.3E-04	1.2E-04	0.001
22.64	6.90	508.00	4.02	0.79	48.65	130	1.309	1.309	0.950	0.79	0.50	0.90	430.54	45.49	0.31	45.79	1.01	431.66	1.40		1	100	1.00	1.00	431.7	0.92	Infin.	0.349	Non-Liq.	6.3	68.9	5.0	73.9	0.02	0.877	1,757	0.506	5.4E-04	1.1E-04	1.0E-04	0.001
23.13	7.05	514.38	4.15	0.81	49.26	130	1.341	1.341	0.948	0.81	0.50	0.89	430.71	45.74	0.33	46.07	1.01	431.84	1.40		1	100	1.00	1.00	431.8	0.91	Infin.	0.348	Non-Liq.	6.2	69.1	5.0	74.1	0.02	0.898	1,780	0.518	5.4E-04	1.1E-04	1.0E-04	0.001
23.62	7.20	423.98	4.36	1.03	40.60	130	1.373	1.373	0.946	1.03	0.50	0.88	350.64	37.60	0.56	38.16	1.01	351.78	1.54		1	100	1.00	1.00	351.8	0.90	Infin.	0.347	Non-Liq.	6.0	58.8	5.0	63.8	0.03	0.920	1,713	0.529	6.1E-04	1.5E-04	1.4E-04	0.002
24.11	7.35	505.86	3.95	0.78	48.44	130	1.405	1.405	0.945	0.78	0.50	0.87	413.75	44.27	0.30	44.57	1.01	414.90	1.40		1	100	1.00	1.00	414.9	0.89	Infin.	0.347	Non-Liq.	6.3	66.4	5.0	71.4	0.02	0.941	1,799	0.541	5.6E-04	1.2E-04	1.1E-04	0.001
24.61	7.50	433.84	3.87	0.89	41.54	130	1.437	1.437	0.943	0.89	0.50	0.86	350.68	37.78	0.41	38.19	1.01	351.85	1.49		1	100	1.00	1.00	351.8	0.88	Infin.	0.346	Non-Liq.	6.1	57.9	5.0	62.9	0.03	0.963	1,745	0.552	6.2E-04	1.6E-04	1.4E-04	0.002
25.10	7.65	420.98	3.36	0.80	40.31	130	1.469	1.469	0.941	0.80	0.50	0.85	336.50	36.22	0.36	36.58	1.01	337.68	1.47		1	100	1.00	1.00	337.7	0.88	Infin.	0.518	Non-Liq.	6.1	55.1	5.0	60.1	0.00	0.984	1,737	0.563	6.5E-04			
25.59	7.80	416.69	3.00	0.72	39.90	130	1.501	1.501	0.940	0.72	0.50	0.84	329.47	35.42	0.27	35.69	1.01	330.66	1.44		1	100	1.00	1.00	330.7	0.87	Infin.	0.521	Non-Liq.	6.2	53.5	5.0	58.5	0.00	1.006	1,740	0.575	6.6E-04			
26.08	7.95	468.27	4.07	0.87	44.84	130	1.533	1.533	0.938	0.87	0.50	0.83	366.49	39.99	0.45	40.44	1.01	367.69	1.47		1	100	1.00	1.00	367.7	0.87	Infin.	0.525	Non-Liq.	6.1	60.1	5.0	65.1	0.00	1.027	1,823	0.586	6.2E-04			
26.57	8.10	527.12	5.14	0.98	50.48	130	1.565	1.565	0.936	0.98	0.50	0.82	408.43	45.10	0.58	45.68	1.01	409.65	1.48		1	100	1.00	1.00	409.6	0.86	Infin.	0.529	Non-Liq.	6.1	67.2	5.0	72.2	0.00	1.049	1,906	0.597	5.8E-04			
27.07	8.25	431.08	4.31	1.00	41.28	130	1.597	1.597	0.934	1.00	0.50	0.81	330.42	36.53	0.61	37.14	1.02	331.64	1.55		1	100	1.00	1.00	331.6	0.86	Infin.	0.533	Non-Liq.	6.0	55.6	5.0	60.6	0.00	1.070	1,816	0.608	6.6E-04			
27.56	8.40	448.56	3.66	0.82	42.95	130	1.629	1.629	0.932	0.82	0.50	0.81	340.44	37.42	0.39	37.81	1.01	341.68	1.47		1	100	1.00	1.00	341.7	0.86	Infin.	0.537	Non-Liq.	6.1	55.9	5.0	60.9	0.00	1.091	1,837	0.618	6.6E-04			
28.05	8.55	523.42	3.72	0.71	50.12	130	1.661	1.661	0.930	0.71	0.50	0.80	393.60	43.24	0.26	43.50	1.01	394.85	1.38		1	100	1.00	1.00	394.9	0.85	Infin.	0.540	Non-Liq.	6.3	62.8	5.0	67.8	0.00	1.113	1,923	0.629	6.1E-04			
28.54	8.70	442.10	3.80	0.86	42.34	130	1.693	1.693	0.928	0.86	0.50	0.79	329.07	36.53	0.44	36.97	1.01	330.34	1.50		1	100	1.00	1.00	330.3	0.85	Infin.	0.544	Non-Liq.	6.1	54.5	5.0	59.5	0.00	1.134	1,858	0.640	6.8E-04			
29.04	8.85	373.11	4.30	1.15	35.73	130	1.725	1.725	0.925	1.16	0.50	0.78	274.66	31.02	0.80	31.82	1.03	275.94	1.65		1	100	1.00	1.00	276.2	0.85	Infin.	0.547	Non-Liq.	5.8	47.8	5.0	52.8	0.00	1.156	1,803	0.650	7.4E-04			
29.53	9.00	360.25	4.62	1.28	34.50	130	1.757	1.757	0.923	1.29	0.52	0.77	260.78	29.94	0.96	30.90	1.03	262.05	1.70		1	100	1.04	1.00	271.4	0.84	Infin.	0.550	Non-Liq.	5.7	46.2	5.0	51.2	0.00	1.177	1,800	0.660	7.6E-04			
30.02	9.15	481.54	4.35	0.90	46.11	130	1.789	1.789	0.920	0.91	0.50	0.77	348.73	39.34	0.50	39.84	1.01	350.03	1.50		1	100	1.00	1.00	350.0	0.84	Infin.	0.553	Non-Liq.	6.1	57.7	5.0	62.7	0.00	1.199	1,944	0.671	6.6E-04			
30.51	9.30	584.43	4.47	0.76	55.96	130	1.821	1.821	0.918	0.77	0.50	0.76	419.75	47.27	0.33	47.59	1.01	421.06	1.39		1	100	1.00	1.00	421.1	0.84	Infin.	0.556	Non-Liq.	6.3	67.1	5.0	72.1	0.00	1.220	2,055	0.681	6.0E-04			
31.00	9.45	612.47	5.03	0.82	58.65	130	1.853	1.853	0.915	0.82	0.50	0.76	436.12	49.60	0.40	50.00	1.01	437.44	1.41		1	100	1.00	1.00	437.4	0.83	Infin.	0.558	Non-Liq.	6.2	70.1	5.0	75.1	0.00	1.241	2,101	0.691	5.9E-04			
31.50	9.60	540.29	5.06	0.94	51.74	130	1.885	1.885	0.913	0.94	0.50	0.75	381.27	43.74	0.54	44.28	1.01	382.60	1.49		1	100	1.00	1.00	382.6	0.83	Infin.	0.560	Non-Liq.	6.1	62.9	5.0	67.9	0.00	1.263	2,049	0.701	6.3E-04			
31.99	9.75	499.33	4.59	0.92	47.82	130	1.917	1.917	0.910	0.92	0.50	0.74	349.29	40.06	0.52	40.58	1.01	350.63	1.50		1	100	1.00	1.00	350.6	0.83	Infin.	0.563	Non-Liq.	6.1	57.9	5.0	62.9	0.00	1.284	2,015	0.710	6.6E-04			

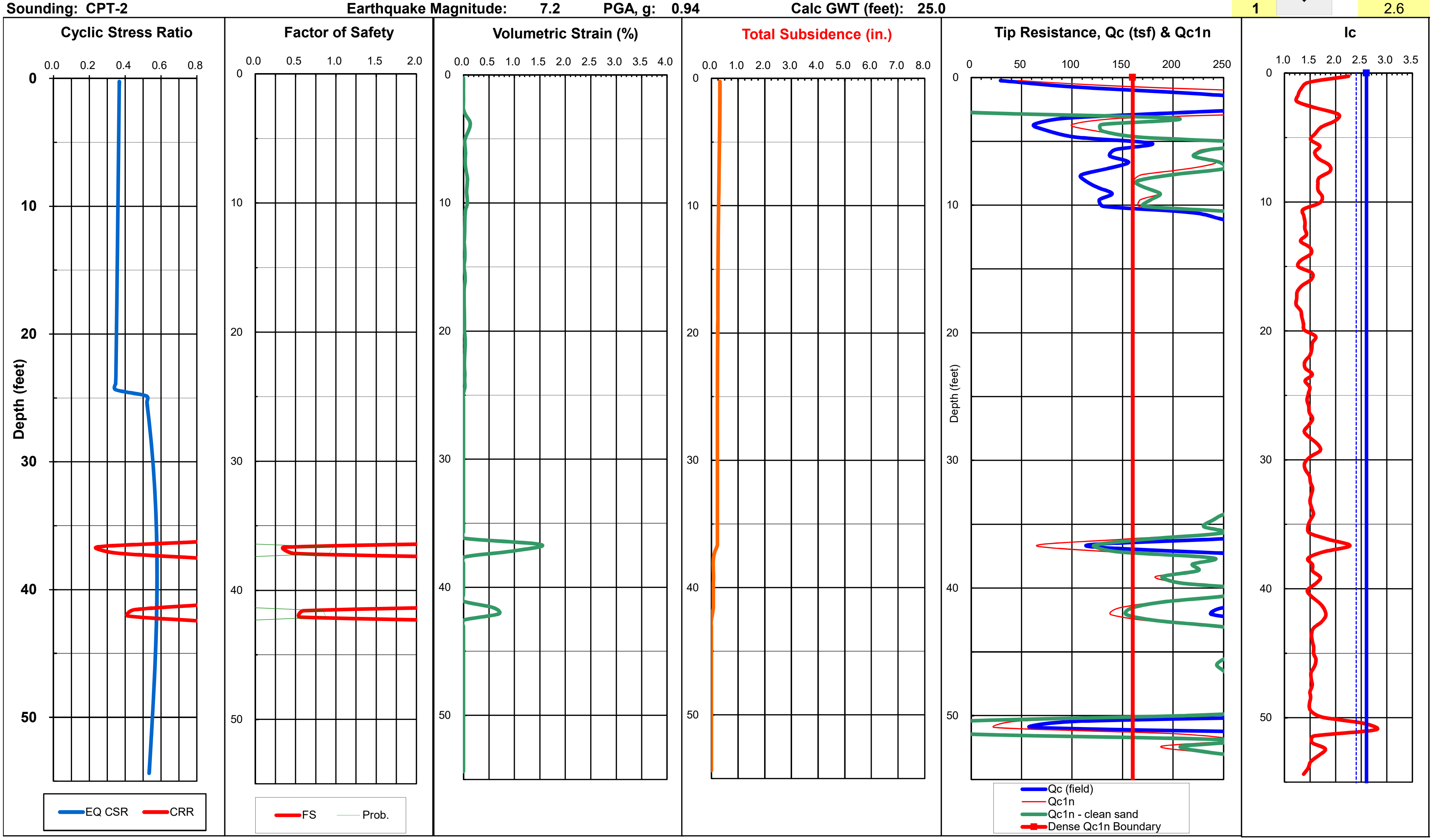
Depth (feet)	(m)	Tip Qc (tsf)	Friction Fs (tsf)	Friction Ratio Rf %	qc MPa	Total Unit Wt. (pcf)	Total Stress po (tsf)	Eff. Stress p'o (tsf)	rd	F %	n	Max 1.70 Cq	Q	Moss qc1 MPa	Moss Δqc MPa	Moss qc_{1mod} MPa	Moss eff K_C	Qc1n	Ic	Overide	Liquef. Suscept. (0 or 1)	Rel. Dens. Dr (%)	K_C	K_H	Clean Sand Qc1n	1.0 Kσ	CRR	Induced M=7.5 CSR	Liquefac. Safety Factor	Qc1n $N_{1(60)}$ Ratio	Equiv. $N_{1(60)}$	FC Adj. $\Delta N_{1(60)}$	Equiv. $N_{1(60)cs}$	Volumetric Strain (%)	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
32.48	9.90	428.21	3.92	0.92	41.01	130	1.949	1.949	0.907	0.92	0.50	0.74	296.85	33.98	0.52	34.49	1.02	298.21	1.55		1	100	1.00	1.00	298.2	0.82	Infin.	0.565	Non-Liq.	6.0	50.0	5.0	55.0	0.00	1.306	1,942	0.720	7.3E-04			
32.97	10.05	434.99	3.69	0.85	41.66	130	1.981	1.981	0.904	0.85	0.50	0.73	299.11	34.15	0.43	34.58	1.01	300.48	1.52		1	100	1.00	1.00	300.5	0.82	Infin.	0.567	Non-Liq.	6.0	49.9	5.0	54.9	0.00	1.327	1,957	0.729	7.3E-04			
33.46	10.20	455.51	3.72	0.82	43.62	130	2.013	2.013	0.901	0.82	0.50	0.73	310.76	35.54	0.40	35.94	1.01	312.14	1.50		1	100	1.00	1.00	312.1	0.82	Infin.	0.568	Non-Liq.	6.1	51.5	5.0	56.5	0.00	1.349	1,991	0.739	7.2E-04			
33.96	10.35	424.82	3.54	0.83	40.68	130	2.045	2.045	0.898	0.84	0.50	0.72	287.43	32.94	0.42	33.35	1.01	288.83	1.53		1	100	1.00	1.00	288.8	0.81	Infin.	0.570	Non-Liq.	6.0	48.1	5.0	53.1	0.00	1.370	1,966	0.748	7.5E-04			
34.45	10.50	373.28	3.07	0.82	35.75	130	2.077	2.077	0.894	0.83	0.50	0.71	250.42	28.60	0.40	29.00	1.01	251.82	1.56		1	100	1.00	1.00	251.8	0.81	Infin.	0.571	Non-Liq.	5.9	42.4	5.0	47.4	0.00	1.391	1,908	0.757	8.2E-04			
34.94	10.65	357.35	2.27	0.64	34.22	130	2.109	2.109	0.891	0.64	0.50	0.71	237.83	26.52	0.17	26.69	1.01	239.24	1.50		1	100	1.00	1.00	239.2	0.81	Infin.	0.573	Non-Liq.	6.1	39.5	5.0	44.5	0.00	1.413	1,882	0.765	8.6E-04			
35.43	10.80	346.57	1.82	0.53	33.19	130	2.141	2.141	0.888	0.53	0.50	0.70	228.86	25.02	0.03	25.05	1.00	230.29	1.46		1	100	1.00	1.00	230.3	0.80	Infin.	0.574	Non-Liq.	6.1	37.5	5.0	42.5	0.00	1.434	1,868	0.774	8.9E-04			
35.93	10.95	378.15	2.41	0.64	36.21	130	2.173	2.173	0.884	0.64	0.50	0.70	247.98	27.85	0.17	28.02	1.01	249.41	1.49		1	100	1.00	1.00	249.4	0.80	Infin.	0.575	Non-Liq.	6.1	41.0	5.0	46.0	0.00	1.456	1,932	0.782	8.3E-04			
36.42	11.10	242.91	3.10	1.28	23.26	130	2.205	2.205	0.880	1.29	0.56	0.66	150.78	18.59	0.97	19.56	1.05	152.16	1.85		1	94	1.15	1.00	174.8	0.80	Infin.	0.576	Non-Liq.	5.4	28.3	5.0	33.3	0.00	1.477	1,749	0.791	1.1E-03			
36.91	11.25	113.96	2.39	2.10	10.91	130	2.237	2.237	0.877	2.14	0.68	0.60	63.55	8.67	2.00	10.67	1.23	64.82	2.28		1	59	1.88	1.00	121.6	0.84	0.247	0.576	0.36	4.5	14.3	5.5	19.8	1.52	1.499	1,480	0.799	1.7E-03			
37.40	11.40	213.79	1.64	0.77	20.47	130	2.269	2.269	0.873	0.77	0.53	0.67	133.58	15.30	0.33	15.63	1.02	135.01	1.74		1	89	1.07	1.00	144.0	0.79	0.358	0.577	0.49	5.6	24.2	4.6	28.8	1.00	1.520	1,689	0.807	1.2E-03			
37.89	11.55	374.30	2.07	0.55	35.84	130	2.301	2.301	0.869	0.56	0.50	0.68	238.44	26.52	0.06	26.59	1.00	239.91	1.46		1	100	1.00	1.00	239.9	0.79	Infin.	0.577	Non-Liq.	6.1	39.0	5.0	44.0	0.00	1.541	1,960	0.814	8.5E-04			
38.39	11.70	344.10	2.34	0.68	32.95	130	2.333	2.333	0.865	0.69	0.50	0.67	217.55	24.74	0.23	24.97	1.01	219.04	1.55		1	100	1.00	1.00	219.0	0.79	Infin.	0.578	Non-Liq.	6.0	36.7	5.0	41.7	0.00	1.563	1,938	0.822	8.8E-04			
38.88	11.85	355.75	2.51	0.71	34.07	130	2.365	2.365	0.861	0.71	0.50	0.67	223.42	25.60	0.26	25.86	1.01	224.91	1.55		1	100	1.00	1.00	224.9	0.78	Infin.	0.578	Non-Liq.	6.0	37.7	5.0	42.7	0.00	1.584	1,967	0.829	8.7E-04			
39.37	12.00	294.17	2.73	0.93	28.17	130	2.397	2.397	0.857	0.94	0.52	0.66	180.73	21.48	0.54	22.02	1.02	182.22	1.70		1	100	1.04	1.00	189.1	0.78	Infin.	0.578	Non-Liq.	5.7	32.1	5.0	37.1	0.00	1.606	1,890	0.836	9.6E-04			
39.86	12.15	333.33	2.59	0.78	31.92	130	2.429	2.429	0.852	0.78	0.50	0.66	206.43	23.94	0.35	24.28	1.01	207.95	1.60		1	100	1.00	1.00	207.9	0.78	Infin.	0.578	Non-Liq.	5.9	35.5	5.0	40.5	0.00	1.627	1,958	0.843	8.9E-04			
40.35	12.30	450.71	2.83	0.63	43.16	130	2.461	2.461	0.848	0.63	0.50	0.66	277.81	31.99	0.16	32.15	1.00	279.34	1.45		1	100	1.00	1.00	279.3	0.78	Infin.	0.577	Non-Liq.	6.2	45.3	5.0	50.3	0.00	1.649	2,119	0.850	7.6E-04			
40.85	12.45	413.77	3.06	0.74	39.62	130	2.493	2.493	0.843	0.74	0.50	0.65	253.26	29.66	0.30	29.96	1.01	254.80	1.53		1	100	1.00	1.00	254.8	0.77	Infin.	0.577	Non-Liq.	6.0	42.4	5.0	47.4	0.00	1.670	2,091	0.856	7.9E-04			
41.34	12.60	306.64	2.72	0.89	29.36	130	2.525	2.525	0.839	0.90	0.51	0.64	184.26	21.96	0.49	22.44	1.02	185.79	1.68		1	100	1.02	1.00	190.4	0.77	Infin.	0.577	Non-Liq.	5.7	32.6	5.0	37.6	0.00	1.691	1,947	0.863	9.3E-04			
41.83	12.75	247.17	2.31	0.94	23.67	130	2.557	2.557	0.834	0.95	0.54	0.62	143.91	17.49	0.54	18.03	1.03	145.42	1.77		1	92	1.09	1.00	158.3	0.77	0.449	0.576	0.60	5.5	26.3	5.3	31.7	0.58	1.713	1,851	0.869	1.1E-03			
42.32	12.90	238.26	2.34	0.98	22.82	130	2.589	2.589	0.830	0.99	0.55	0.61	136.69	16.84	0.60	17.44	1.04	138.19	1.81		1	90	1.11	1.00	153.5	0.77	0.416	0.575	0.56	5.5	25.3	5.4	30.7	0.69	1.734	1,843	0.875	1.1E-03			
42.81	13.05	298.99	2.88	0.96	28.63	130	2.621	2.621	0.825	0.97	0.52	0.62	174.35	21.31	0.58	21.89	1.03	175.89	1.72		1	100	1.05	1.00	185.2	0.76	Infin.	0.574	Non-Liq.	5.6	31.3	5.0	36.3	0.00	1.756	1,961	0.881	9.4E-04			
43.31	13.20	420.64	3.47	0.82	40.28	130	2.653	2.653	0.820	0.83	0.50	0.63	249.51	29.95	0.41	30.35	1.01	251.10	1.56		1	100	1.00	1.00	251.1	0.76	Infin.	0.573	Non-Liq.	5.9	42.3	5.0	47.3	0.00	1.777	2,155	0.886	7.7E-04			
43.80	13.35	465.24	3.75	0.81	44.55	130	2.685	2.685	0.816	0.81	0.50	0.63	274.46	33.10	0.38	33.49	1.01	276.05	1.53		1	100	1.00	1.00	276.1	0.76	Infin.	0.572	Non-Liq.	6.0	46.0	5.0	51.0	0.00	1.799	2,223	0.892	7.3E-04			
44.29	13.50	472.39	3.97	0.84	45.24	130	2.717	2.717	0.811	0.85	0.50	0.62	277.04	33.69	0.43	34.12	1.01	278.64	1.54		1	100	1.00	1.00	278.6	0.76	Infin.	0.571	Non-Liq.	6.0	46.6	5.0	51.6	0.00	1.820	2,245	0.897	7.2E-04			
44.78	13.65	458.31	4.07	0.89	43.89	130	2.749	2.749	0.806	0.89	0.50	0.62	267.15	32.73	0.48	33.21	1.01	268.76	1.57		1	100	1.00	1.00	268.8	0.75	Infin.	0.570	Non-Liq.	5.9	45.4	5.0	50.4	0.00	1.842	2,240	0.902	7.3E-04			
45.28	13.80	462.89	4.13	0.89	44.33	130	2.781	2.781	0.801	0.90	0.50	0.62	268.26	32.97	0.49	33.46	1.01	269.88	1.57		1	100	1.00	1.00	269.9	0.75	Infin.	0.569	Non-Liq.	5.9	45.5	5.0	50.5	0.00	1.863	2,256	0.907	7.2E-04			
45.77	13.95	434.52	4.19	0.96	41.61	130	2.813	2.813	0.796	0.97	0.50	0.61	250.27	31.01	0.58	31.59	1.02	251.90	1.61		1	100	1.00	1.00	251.9	0.75	Infin.	0.567	Non-Liq.	5.8	43.2	5.0	48.2	0.00	1.884	2,232	0.912	7.4E-04			
46.26	14.10	421.93	3.59	0.85	40.40	130	2.844	2.844	0.791	0.86	0.50	0.61	241.58	29.50	0.44	29.93	1.01	243.22	1.58		1	100	1.00	1.00	243.2	0.75	Infin.	0.566	Non-Liq.	5.9	41.3	5.0	46.3	0.00	1.906	2,215	0.916	7.6E-04			
46.75	14.25	436.64	3.09	0.71	41.81	130	2.876	2.876	0.786	0.71	0.50	0.61	248.65	29.74	0.26	30.00	1.01	250.29	1.52		1	100	1.00	1.00	250.3	0.75	Infin.	0.564	Non-Liq.	6.0	41.5	5.0	46.5	0.00	1.927	2,232	0.921	7.5E-04			
47.24	14.40	448.68	3.28	0.73	42.97	130	2.908	2.908	0.781	0.74	0.50	0.60	254.12	30.65	0.29	30.93	1.01	255.78	1.52		1	100	1.00	1.00	255.8	0.74	Infin.	0.563	Non-Liq.	6.0	42.5	5.0	47.5	0.00	1.949	2,260	0.925	7.4E-04			
47.74	14.55	457.48	3.61	0.79	43.81	130	2.940	2.940	0.776	0.80	0.50	0.60	257.70	31.51	0.36	31.87	1.01	259.37	1.54		1	100	1.00	1.00	259.4	0.74	Infin.	0.561	Non-Liq.	6.0	43.4	5.0	48.4	0.00	1.970	2,286	0.929	7.2E-04			
48.23	14.70	511.00	3.87	0.76	48.93	130	2.972	2.972	0.771	0.76	0.50	0.60	286.48	35.14	0.32	35.46	1.01	288.15	1.50		1	100	1.00	1.00	288.2	0.74	Infin.	0.559	Non-Liq.	6.1	47.5	5.0	52.5	0.00	1.992	2,362	0.933	6.8E-04			
48.72	14.85	501.91	3.87	0.77	48.06	130	3.004	3.004	0.766	0.78	0.50	0.59	279.83	34.43	0.34	34.77	1.01	281.51	1.51		1	100	1.00	1.00	281.5	0.74	Infin.	0.558	Non-Liq.	6.0	46.6	5.0	51.6	0.00	2.013	2,361	0.937	6.8E-04			
49.21	15.00	551.14	4.26	0.77	52.78	130	3.036	3.036	0.761	0.78	0.50	0.59	305.80	37.93	0.34	38.27	1.01	307.50	1.48		1	100	1.00	1.00	307.5	0.73	Infin.	0.556	Non-Liq.	6.1	50.5	5.0	55.5	0.00	2.034	2,432	0.941	6.5E-04			
49.70	15.15	581.26	5.11	0.88	55.66	130	3.068	3.068	0.756	0.88	0.50	0.59	320.90	40.70	0.47	41.17	1.01	322.61	1.51		1	100	1.00	1.00	322.6	0.73	Infin.	0.554	Non-Liq.	6.0	53.5	5.0	58.5	0.00	2.056	2,487	0.945	6.3E-04			
50.20	15.30	408.07	4.90	1.20	39.08	130	3.100	3.100	0.751	1.21	0.52	0.57	218.04	28.95	0.86	29.81	1.03	219.71	1.73		1	100	1.05	1.00	231.8	0.73	Infin.	0.552	Non-Liq.	5.6	39.1	5.0	44.1	0.00	2.077	2,276	0.948	7.4E-04			
50.69	15.45	104.12	3.53	3.39	9.97	130	3.132	3.132	0.746	3.50	0.75	0.44	42.37	7.46	3.56	11.03		43.68	2.55		0			1.00		0.85		0.550	Non-Liq.	4.0	10.9			0.00	2.099						
51.18	15.60	61.42	2.28	3.71	5.88	130	3.164	3.164	0.741	3.91	0.81	0.41	22.66	4.20	3.95	8.15		23.89	2.78		0			1.00		0.85		0.548	Non-Liq.	3.5	6.7			0.00	2.120						
51.67	15.75	372.77	2.49	0.67	35.70	130	3.196	3.196	0.736	0.67	0.50	0.58	200.97	24.08	0.21	24.28		203.47	1.57		0			1.00		0.85		0.546	Non-Liq.	5.9	34.3			0.00	2.142						
52.17	15.90	482.57	3.74	0.77	46.21	130	3.228	3.228	0.731	0.78	0.50	0.57	259.37	32.28	0.34	32.62	1.01	261.11	1.53		1	100	1.00	1.00	261.1	0.72	Infin.	0.544	Non-Liq.	6.0	43.6	5.0	48.6	0.00	2.163	2,398	0.961	6.8E-04			
52.66	16.05	366.45	4.74	1.29	35.09	130	3.260	3.260	0.726	1.30	0.54	0.54	186.45	25.68	0.97	26.66	1.04	188.12	1.79		1	100	1.10	1.00	207.5	0.72	Infin.	0.542	Non-Liq.	5.5	34.3	5.0	39.3	0.00	2.184	2,246	0.964	7.7E-04			
53.15	16.20	439.58	4.78	1.09	42.09	130	3.292	3.292	0.721	1.09	0.51	0.56	231.16	30.43	0.72	31.15	1.02	232.91	1.68		1	100	1.02	1.00	237.9	0.72	Infin.	0.540	Non-Liq.	5.7	40.7	5.0	45.7	0.00	2.206	2,374	0.967	6.9E-04			
53.64	16.35	547.08	4.41	0.81	52.39	130	3.324	3.324	0.716	0.81	0.50	0.56	289.94	36.81	0.38	37.18	1.01	291.71	1.51		1	100	1.00	1.00	291.7	0.72	Infin.	0.538	Non-Liq.	6.0	48.3	5.0	53.3	0.00	2.227	2,511	0.970	6.3E-04			
54.13	16.50	609.06	4.63	0.76	58.32	130	3.356	3.356	0.712	0.76	0.50	0.56	321.43	40.82	0.32	41.14	1.01	323.21	1.46		1	100	1.00	1.00	323.2	0.71	Infin.	0.536	Non-Liq.	6.1	52.7	5.0	57.7	0.00	2.249	2,591	0.973	6.0E-04			
54.63	16.65	674.32	4.22	0.63	64.57	130	3.388	3.388	0.707	0.63	0.50	0.56	354.36	44.06	0.15	44.21	1.00	356.15	1.37		1	100	1.00	1.00	356.2	0.71	Infin.	0.534	Non-Liq.	6.3	56.4	5.0	61.4	0.00	2.270	2,658	0.976	5.7E-04			

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Rio Mesa High School Bleachers **Project No: 303280-002** Method Used: 1 1998 NCEER (Robertson & Wride)

Settlement Analysis using Tokimatsu & Seed (1987), clean sand Qc1n/N1(60) ratio =5 Plot 1 Limiting Ic: 2.6

Sounding: CPT-2 **Earthquake Magnitude: 7.2** **PGA, g: 0.94** **Calc GWT (feet): 25.0**



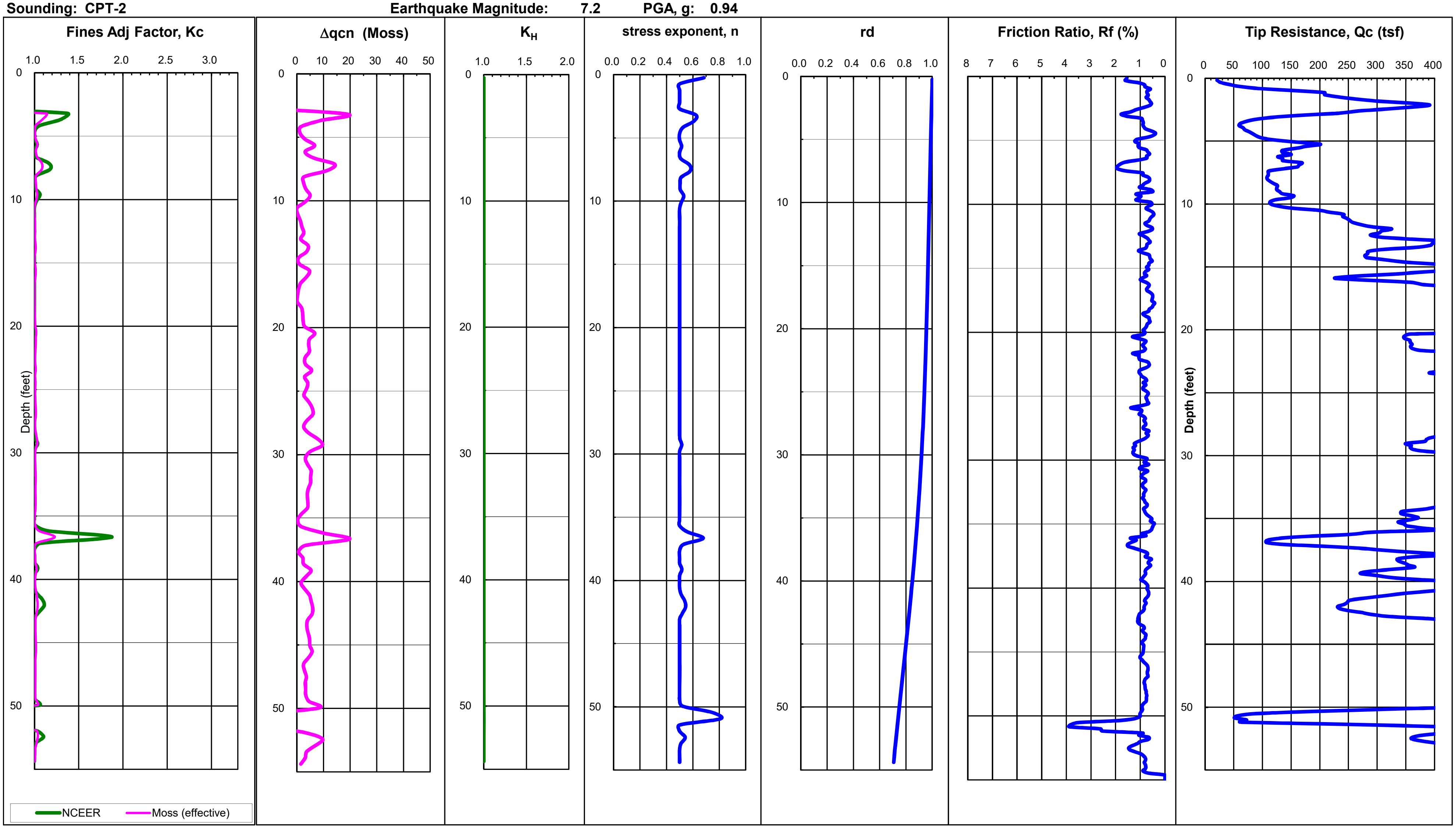
Total Thickness of Liquefiable Layers: 2.0 feet **Estimated Total Ground Subsidence (Settlement): 0.3 inches**

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

3 avg increment =0.15m Qc1n/N1(60): 5 | Method Used: 1998 NCEER (Robertson & Wride)

Ignore 1st/last increment into sand/silt soils: 0

Sounding: CPT-2 | **Earthquake Magnitude: 7.2** | **PGA, g: 0.94**



CPT-LIQUEFY.XLS - A SPREADSHEET FOR EMPIRICAL ESTIMATION OF LIQUEFACTION POTENTIAL USING CPT DATA

Developed 2003 by Shelton L. Stringer, GE, Earth Systems Southwest

Project: Rio Mesa High School Bleachers
Job No: 303280-002
Date: 2/20/2020
Sounding: CPT-2

Liquefaction Analysis using 1998 NCEER (Robertson & Wride) method
Settlement Analysis using Tokimatsu & Seed (1987), clean sand Qc1n/N1(60) ratio =5

EARTHQUAKE INFORMATION:

Magnitude:	7.2	7.5
PGA, g:	0.94	0.85
MSF:	1.11	
GWT, feet:	55.0	
Calc GWT, feet:	55.0	

Plot: 2
Method Used: 1 1998 NCEER (Robertson & Wride)
Averaging Increment: 3 0.15 m
Induced CSR (M=7.5) = 0.65*PGA*(po/p'o)*rd/MSF
Clean Sand Qc1n = C_Q*K_C*K_H*Qc
SF = $CRR_{7.5}$*Kσ/CSR

Ignore 1st/last increment into sand/silt soils: 1 yes
Ignore/remediate upper: 1.0 m
Unit Weight of unsaturated soils: 115 pcf
Unit Weight of saturated soils: 130 pcf
Limiting Ic for liquefiable soils: 2.60 Limiting Ic for K_H: 2.6

Use Moss @ P_L: 15%
Use Tokimatsu & Seed (0) or Ishihara &Yoshmine (1): 0
Required SF: 1.50 Max $\Delta N_{1(60)}$ - post liquefied: 5.5
Min SF of Liquefiable Layers: 0.00 Max $\Delta N_{1(60)}$ - non liquefied: 5.0
Avg SF of Liquefiable Layers: #DIV/0!

Total Liquefied Thickness (feet)	Total Induced Subsidence (inches)
0.0	0.3

SETTLEMENT OF DRY SANDS

Qc1n / N1(60) Ratio for clean sand: 5

p = 0.67*po
τ_{av} = 0.65*PGA*po*rd
G_{max} = 447*$N_{1(60)CS}^{(1/3)}$*$p^{0.5}$
a = 0.0389*(p/1)+0.124
b = 6400*$(p/1)^{(-0.6)}$
γ = [1+a*EXP(b*τ_{av}/G_{max})]/[(1+a)*τ_{av}/G_{max}]
E_{15} = γ*$(N_{1(60)CS}/20)^{-1.2}$
Nc = $(MAG-4)^{2.17}$
E_{nc} = $(Nc/15)^{0.45}$*E15
S = 2*H*E_{nc} Nc = 12.5

Depth (feet)	(m)	Tip Qc (tsf)	Friction Fs (tsf)	Friction Ratio Rf %	qc MPa	Total Unit Wt. (pcf)	Total Stress po (tsf)	Eff. Stress p'o (tsf)	rd	F %	n	Max 1.70 Cq	Q	Moss qc1 MPa	Moss Δqc MPa	Moss qc_{1mod} MPa	Moss eff K_C	Qc1n	Ic	Overide	Liquef. Suscept. (0 or 1)	Rel. Dens. Dr (%)	K_C	K_H	Clean Sand Qc1n	1.0 Kσ	CRR	Induced M=7.5 CSR	Liquefac. Safety Factor	Qc1n $N_{1(60)}$ Ratio	Equiv. $N_{1(60)}$	FC Adj. $\Delta N_{1(60)}$	Equiv. $N_{1(60)cs}$	*Volumetric Strain (%)*	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
0.49	0.15	29.10	0.40	1.36	2.79	115	0.028	0.028	1.000	1.36	0.68	1.70	46.72	4.74	0.93	5.66		46.76	2.25		0			1.00		1.00		0.367	**Non-Liq.**	4.6	10.2			**0.00**	0.019						
0.98	0.30	101.66	0.33	0.33	9.73	115	0.057	0.057	1.000	0.33	0.50	1.70	163.25	16.55	0.00	16.55		163.34	1.46		0			1.00		1.00		0.367	**Non-Liq.**	6.1	26.6			**0.00**	0.038						
1.48	0.45	215.01	1.12	0.52	20.59	115	0.085	0.085	0.999	0.52	0.50	1.70	345.34	35.00	0.02	35.03		345.47	1.32		0			1.00		1.00		0.367	**Non-Liq.**	6.4	53.9			**0.00**	0.057						
1.97	0.60	301.85	1.78	0.59	28.91	115	0.113	0.113	0.997	0.59	0.50	1.70	484.84	49.14	0.10	49.24		485.02	1.26		0			1.00		1.00		0.366	**Non-Liq.**	6.5	74.3			**0.00**	0.076						
2.46	0.75	355.53	2.24	0.63	34.05	115	0.141	0.141	0.996	0.63	0.50	1.70	571.03	57.88	0.14	58.02		571.26	1.25		0			1.00		1.00		0.366	**Non-Liq.**	6.6	87.1			**0.00**	0.095						
2.95	0.90	221.02	2.81	1.27	21.17	115	0.170	0.170	0.995	1.27	0.50	1.70	354.87	35.98	0.83	36.81		355.14	1.61		0			1.00		1.00		0.365	**Non-Liq.**	5.8	60.8			**0.00**	0.114						
3.44	1.05	91.96	2.13	2.31	8.81	115	0.198	0.198	0.994	2.32	0.62	1.70	147.44	14.95	1.95	16.90	1.13	147.76	2.05		1	93	1.37	1.00	202.8	1.00	Infin.	0.365	**Non-Liq.**	5.0	29.7	5.0	34.7	**0.06**	0.133	531	0.080	5.8E-04	3.0E-04	2.8E-04	0.003
3.94	1.20	62.05	0.83	1.33	5.94	115	0.226	0.226	0.993	1.34	0.61	1.70	99.34	10.10	0.89	11.00	1.09	99.71	2.00		1	77	1.29	1.00	129.0	1.00	0.280	0.364	**Non-Liq.**	5.1	19.6	5.0	24.6	**0.13**	0.152	506	0.092	9.1E-04	7.1E-04	6.6E-04	0.008
4.43	1.35	76.41	0.49	0.64	7.32	115	0.255	0.255	0.992	0.64	0.52	1.70	122.36	12.44	0.15	12.59	1.01	122.77	1.72		1	85	1.05	1.00	129.3	1.00	0.281	0.364	**Non-Liq.**	5.6	21.8	4.0	25.9	**0.12**	0.171	546	0.103	8.8E-04	6.4E-04	5.9E-04	0.007
4.92	1.50	103.62	0.63	0.61	9.92	115	0.283	0.283	0.990	0.61	0.50	1.70	166.05	16.87	0.12	16.99	1.01	166.50	1.61		1	98	1.00	1.00	166.5	1.00	Infin.	0.364	**Non-Liq.**	5.9	28.4	4.9	33.3	**0.07**	0.190	626	0.114	6.6E-04	3.6E-04	3.3E-04	0.004
5.41	1.65	178.97	1.42	0.79	17.14	115	0.311	0.311	0.989	0.79	0.50	1.70	287.07	27.66	0.32	27.98	1.01	287.57	1.51		1	100	1.00	1.00	287.6	1.00	Infin.	0.363	**Non-Liq.**	6.0	47.6	5.0	52.6	**0.02**	0.209	765	0.125	4.3E-04	1.3E-04	1.2E-04	0.001
5.91	1.80	142.45	1.61	1.13	13.64	115	0.340	0.340	0.988	1.13	0.52	1.70	228.35	20.59	0.67	21.27	1.03	228.89	1.69		1	100	1.03	1.00	236.0	1.00	Infin.	0.363	**Non-Liq.**	5.7	40.2	5.0	45.2	**0.03**	0.228	760	0.137	5.1E-04	1.9E-04	1.7E-04	0.002
6.40	1.95	137.32	1.09	0.79	13.15	115	0.368	0.368	0.987	0.79	0.50	1.70	219.53	20.39	0.31	20.70	1.02	220.12	1.59		1	100	1.00	1.00	220.1	1.00	Infin.	0.362	**Non-Liq.**	5.9	37.4	5.0	42.4	**0.04**	0.246	774	0.148	5.5E-04	2.2E-04	2.1E-04	0.002
6.89	2.10	155.81	1.72	1.10	14.92	115	0.396	0.396	0.986	1.10	0.51	1.65	242.06	21.20	0.65	21.85	1.03	242.68	1.67		1	100	1.01	1.00	246.2	1.00	Infin.	0.362	**Non-Liq.**	5.7	42.3	5.0	47.3	**0.03**	0.265	833	0.159	5.1E-04	1.8E-04	1.7E-04	0.002
7.38	2.25	135.08	2.49	1.84	12.94	115	0.424	0.424	0.985	1.85	0.57	1.69	215.16	17.13	1.44	18.57	1.08	215.84	1.87		1	100	1.16	1.00	251.0	1.00	Infin.	0.361	**Non-Liq.**	5.3	40.5	5.0	45.5	**0.04**	0.284	851	0.170	5.4E-04	2.0E-04	1.9E-04	0.002
7.87	2.40	109.17	1.71	1.57	10.45	115	0.453	0.453	0.984	1.57	0.58	1.64	168.05	14.01	1.14	15.15	1.08	168.75	1.89		1	99	1.18	1.00	198.4	1.00	Infin.	0.361	**Non-Liq.**	5.3	31.8	5.0	36.8	**0.06**	0.303	819	0.181	6.8E-04	3.3E-04	3.0E-04	0.004
8.37	2.55	113.57	0.86	0.75	10.88	115	0.481	0.481	0.983	0.76	0.51	1.50	160.01	15.39	0.27	15.67	1.02	160.69	1.68		1	97	1.02	1.00	164.2	1.00	Infin.	0.361	**Non-Liq.**	5.7	28.1	4.7	32.8	**0.08**	0.322	813	0.193	7.8E-04	4.3E-04	3.9E-04	0.005
8.86	2.70	125.19	0.93	0.74	11.99	115	0.509	0.509	0.982	0.75	0.50	1.45	170.31	16.46	0.26	16.72	1.02	171.01	1.65		1	99	1.00	1.00	171.8	1.00	Infin.	0.360	**Non-Liq.**	5.8	29.7	4.7	34.4	**0.07**	0.341	849	0.204	7.5E-04	3.9E-04	3.6E-04	0.004
9.35	2.85	139.56	1.15	0.83	13.36	115	0.538	0.538	0.981	0.83	0.51	1.41	184.98	17.61	0.35	17.96	1.02	185.69	1.66		1	100	1.01	1.00	187.1	1.00	Infin.	0.360	**Non-Liq.**	5.8	32.3	5.0	37.3	**0.06**	0.360	896	0.215	7.0E-04	3.3E-04	3.1E-04	0.004
9.84	3.00	126.82	1.23	0.97	12.14	115	0.566	0.566	0.979	0.97	0.53	1.39	166.37	15.53	0.50	16.04	1.03	167.11	1.74		1	98	1.06	1.00	177.7	1.00	Infin.	0.360	**Non-Liq.**	5.6	29.9	5.0	34.9	**0.07**	0.379	899	0.226	7.6E-04	3.9E-04	3.6E-04	0.004
10.33	3.15	130.94	1.04	0.80	12.54	115	0.594	0.594	0.978	0.80	0.51	1.34	165.65	15.96	0.32	16.28	1.02	166.40	1.68		1	98	1.03	1.00	170.6	1.00	Infin.	0.359	**Non-Liq.**	5.7	29.2	5.0	34.1	**0.08**	0.398	915	0.237	7.9E-04	4.2E-04	3.8E-04	0.005
10.83	3.30	218.95	1.00	0.46	20.97	115	0.623	0.623	0.977	0.46	0.50	1.30	269.01	26.79	0.00	26.79	1.00	269.78	1.36		1	100	1.00	1.00	269.8	1.00	Infin.	0.359	**Non-Liq.**	6.3	42.6	5.0	47.6	**0.04**	0.417	1,046	0.248	5.9E-04	2.1E-04	1.9E-04	0.002
11.32	3.45	246.56	1.31	0.53	23.61	115	0.651	0.651	0.976	0.53	0.50	1.27	296.34	29.04	0.03	29.08	1.00	297.13	1.38		1	100	1.00	1.00	297.1	1.00	Infin.	0.358	**Non-Liq.**	6.3	47.1	5.0	52.1	**0.03**	0.436	1,103	0.259	5.5E-04	1.7E-04	1.6E-04	0.002
11.81	3.60	273.30	1.70	0.62	26.17	115	0.679	0.679	0.975	0.62	0.50	1.25	321.61	31.15	0.13	31.28	1.00	322.41	1.40		1	100	1.00	1.00	322.4	1.00	Infin.	0.358	**Non-Liq.**	6.3	51.5	5.0	56.5	**0.03**	0.455	1,157	0.270	5.2E-04	1.5E-04	1.4E-04	0.002
12.30	3.75	312.17	2.13	0.68	29.89	115	0.707	0.707	0.974	0.68	0.50	1.22	360.02	34.69	0.19	34.88	1.01	360.84	1.40		1	100	1.00	1.00	360.8	1.00	Infin.	0.358	**Non-Liq.**	6.3	57.6	5.0	62.6	**0.02**	0.474	1,222	0.281	4.9E-04	1.2E-04	1.1E-04	0.001
12.80	3.90	316.44	2.36	0.75	30.30	115	0.736	0.736	0.973	0.75	0.50	1.20	357.83	34.48	0.26	34.74	1.01	358.66	1.43		1	100	1.00	1.00	358.7	1.00	Infin.	0.357	**Non-Liq.**	6.2	57.8	5.0	62.8	**0.02**	0.493	1,248	0.292	4.9E-04	1.2E-04	1.1E-04	0.001
13.29	4.05	403.23	2.58	0.64	38.61	115	0.764	0.764	0.972	0.64	0.50	1.18	447.64	43.42	0.15	43.57	1.00	448.49	1.31		1	100	1.00	1.00	448.5	1.00	Infin.	0.357	**Non-Liq.**	6.4	69.8	5.0	74.8	**0.02**	0.512	1,347	0.303	4.4E-04	9.0E-05	8.3E-05	0.001
13.78	4.20	320.39	2.88	0.90	30.68	115	0.792	0.792	0.971	0.90	0.50	1.16	349.06	33.75	0.43	34.17	1.01	349.93	1.50		1	100	1.00	1.00	349.9	1.00	Infin.	0.356	**Non-Liq.**	6.1	57.7	5.0	62.7	**0.02**	0.531	1,294	0.313	5.1E-04	1.3E-04	1.2E-04	0.001
14.27	4.35	281.28	2.36	0.84	26.94	115	0.821	0.821	0.970	0.84	0.50	1.14	301.00	29.42	0.36	29.79	1.01	301.88	1.52		1	100	1.00	1.00	301.9	1.00	Infin.	0.356	**Non-Liq.**	6.0	50.1	5.0	55.1	**0.03**	0.550	1,261	0.324	5.7E-04	1.7E-04	1.6E-04	0.002
14.76	4.50	351.34	1.96	0.56	33.64	115	0.849	0.849	0.969	0.56	0.50	1.12	369.83	36.67	0.06	36.73	1.00	370.73	1.32		1	100	1.00	1.00	370.7	1.00	Infin.	0.356	**Non-Liq.**	6.4	57.9	5.0	62.9	**0.02**	0.569	1,340	0.335	5.2E-04	1.3E-04	1.2E-04	0.001
15.26	4.65	467.81	2.79	0.60	44.80	115	0.877	0.877	0.968	0.60	0.50	1.10	484.69	47.92	0.10	48.03	1.00	485.60	1.27		1	100	1.00	1.00	485.6	1.00	Infin.	0.355	**Non-Liq.**	5.5	87.8	5.0	92.8	**0.01**	0.588	1,551	0.346	4.0E-04	6.3E-05	5.8E-05	0.001
15.75	4.80	320.30	3.03	0.95	30.67	115	0.906	0.906	0.967	0.95	0.50	1.08	326.32	32.25	0.48	32.73	1.01	327.24	1.53		1	100	1.00	1.00	327.2	1.00	Infin.	0.355	**Non-Liq.**	6.0	54.6	5.0	59.6	**0.03**	0.607	1,360	0.357	5.5E-04	1.5E-04	1.4E-04	0.002
16.24	4.95	292.71	2.49	0.85	28.03	115	0.934	0.934	0.966	0.85	0.50	1.06	293.54	29.26	0.37	29.63	1.01	294.48	1.53		1	100	1.00	1.00	294.5	1.00	Infin.	0.355	**Non-Liq.**	6.0	49.0	5.0	54.0	**0.03**	0.626	1,336	0.367	6.0E-04	1.8E-04	1.7E-04	0.002
16.73	5.10	409.29	2.62	0.64	39.19	115	0.962	0.962	0.965	0.64	0.50	1.05	404.72	40.55	0.15	40.70	1.00	405.68	1.34		1	100	1.00	1.00	405.7	1.00	Infin.	0.354	**Non-Liq.**	6.4	63.7	5.0	68.7	**0.02**	0.645	1,470	0.378	5.1E-04	1.2E-04	1.1E-04	0.001
17.22	5.25	499.33	2.80	0.56	47.82	115	0.990	0.990	0.964	0.56	0.50	1.03	486.83	48.98	0.06	49.04	1.00	487.80	1.25		1	100	1.00	1.00	487.8	1.00	Infin.	0.354	**Non-Liq.**	5.5	88.2	5.0	93.2	**0.01**	0.664	1,651	0.389	4.2E-04	6.6E-05	6.0E-05	0.001
17.72	5.40	482.48	2.53	0.52	46.20	115	1.019	1.019	0.962	0.53	0.50	1.02	463.77	46.87	0.03	46.89	1.00	464.75	1.24		1	100	1.00	1.00	464.7	1.00	Infin.	0.353	**Non-Liq.**	5.5	84.0	5.0	89.0	**0.01**	0.683	1,649	0.399	4.3E-04	7.2E-05	6.6E-05	0.001
18.21	5.55	497.12	2.55	0.51	47.60	115	1.047	1.047	0.961	0.51	0.50	1.01	471.33	47.79	0.01	47.81	1.00	472.33	1.23		1	100	1.00	1.00	472.3	1.00	Infin.	0.353	**Non-Liq.**	5.5	85.4	5.0	90.4	**0.01**	0.701	1,680	0.410	4.3E-04	7.1E-05	6.5E-05	0.001
18.70	5.70	499.04	3.35	0.67	47.79	115	1.075	1.075	0.960	0.67	0.50	0.99	466.86	47.53	0.18	47.71	1.00	467.87	1.32		1	100	1.00	1.00	467.9	0.99	Infin.	0.352	**Non-Liq.**	6.4	72.9	5.0	77.9	**0.02**	0.720	1,621	0.421	4.8E-04	9.5E-05	8.7E-05	0.001
19.19	5.85	507.41	3.60	0.71	48.59	115	1.104	1.104	0.959	0.71	0.50	0.98	468.56	47.92	0.22	48.14	1.00	469.59	1.34		1	100	1.00	1.00	469.6	0.98	Infin.	0.352	**Non-Liq.**	6.4	73.6	5.0	78.6	**0.02**	0.739	1,647	0.431	4.9E-04	9.4E-05	8.6E-05	0.001
19.69	6.00	467.05	3.38	0.72	44.72	115	1.132	1.132	0.958	0.73	0.50	0.97	425.76	43.73	0.24	43.97	1.01	426.79	1.37		1	100	1.00	1.00	426.8	0.97	Infin.	0.352	**Non-Liq.**	6.3	67.6	5.0	72.6	**0.02**	0.758	1,624	0.442	5.2E-04	1.1E-04	1.0E-04	0.001
20.18	6.15	493.67	3.89	0.79	47.27	115	1.160	1.160	0.956	0.79	0.50	0.95	444.54	45.91	0.31	46.22	1.01	445.59	1.39		1	100	1.00	1.00	445.6	0.96	Infin.	0.351	**Non-Liq.**	6.3	70.9	5.0	75.9	**0.02**	0.777	1,669	0.452	5.1E-04	1.0E-04	9.4E-05	0.001
20.67	6.30	350.65	3.99	1.14	33.58	115	1.188	1.188	0.955	1.14	0.50	0.94	311.65	32.45	0.68	33.12	1.02	312.71	1.61		1	100	1.00	1.00	312.7	0.95	Infin.	0.351	**Non-Liq.**	5.9	53.5	5.0	58.5	**0.03**	0.796	1,548	0.462	6.2E-04	1.7E-04	1.6E-04	0.002
21.16	6.45	358.36	3.40	0.95	34.32	115	1.217	1.217	0.954	0.95	0.50	0.93	314.77	32.84	0.48	33.32	1.01	315.85	1.54		1	100	1.00	1.00	315.8	0.95	Infin.	0.350	**Non-Liq.**	6.0	52.9	5.0	57.9	**0.03**	0.815	1,561	0.473	6.3E-04	1.8E-04	1.6E-04	0.002
21.65	6.60	365.78	3.39	0.93	35.03	115	1.245	1.245	0.952	0.93	0.50	0.92	317.62	33.27	0.45	33.72	1.01	318.70	1.53		1	100	1.00	1.00	318.7	0.94	Infin.	0.350	**Non-Liq.**	6.0	53.1	5.0	58.1	**0.03**	0.834	1,582	0.483	6.3E-04	1.7E-04	1.6E-04	0.002
22.15	6.75	438.62	4.15	0.95	42.00	115	1.273	1.273	0.951	0.95	0.50	0.91	376.79	39.71	0.47	40.19	1.01	377.89	1.49		1	100	1.00	1.00	377.9	0.93	Infin.	0.349	**Non-Liq.**	6.1	62.2	5.0	67.2	**0.02**	0.853	1,679	0.493	5.7E-04	1.3E-04	1.2E-04	0.001
22.64	6.90	508.00	4.02	0.79	48.65	115	1.302	1.302	0.950	0.79	0.50	0.90	431.77	45.57	0.31	45.88	1.01	432.88	1.40		1	100	1.00	1.00	432.9	0.92	Infin.	0.349	**Non-Liq.**	6.3	69.1	5.0	74.1	**0.02**	0.872	1,753	0.503	5.4E-04	1.1E-04	1.0E-04	0.001
23.13	7.05	514.38	4.15	0.81	49.26	115	1.330	1.330	0.948	0.81	0.50	0.89	432.51	45.86	0.33	46.19	1.01	433.63	1.40		1	100	1.00	1.00	433.6	0.91	Infin.	0.348	**Non-Liq.**	6.3	69.4	5.0	74.4	**0.02**	0.891	1,775	0.514	5.4E-04	1.1E-04	1.0E-04	0.001
23.62	7.20	423.98	4.36	1.03	40.60	115	1.358	1.358	0.946	1.03	0.50	0.88	352.55	37.72	0.56	38.28	1.01	353.68	1.54		1	100	1.00	1.00	353.7	0.90	Infin.	0.347	**Non-Liq.**	6.0	59.1	5.0	64.1	**0.03**	0.910	1,707	0.524	6.0E-04	1.5E-04	1.4E-04	0.002
24.11	7.35	505.86	3.95	0.78	48.44	115	1.387	1.387	0.945	0.78	0.50	0.87	416.51	44.46	0.30	44.75	1.01	417.65	1.40		1	100	1.00	1.00	417.7	0.90	Infin.	0.347	**Non-Liq.**	6.3	66.8	5.0	71.8	**0.02**	0.929	1,791	0.534	5.6E-04	1.2E-04	1.1E-04	0.001
24.61	7.50	433.84	3.87	0.89	41.54	115	1.415	1.415	0.943	0.89	0.50	0.86	353.44	37.96	0.41	38.37	1.01	354.59	1.49		1	100	1.00	1.00	354.6	0.89	Infin.	0.346	**Non-Liq.**	6.1	58.3	5.0	63.3	**0.03**	0.948	1,735	0.544	6.1E-04	1.5E-04	1.4E-04	0.002
25.10	7.65	420.98	3.36	0.80	40.31	115	1.443	1.443	0.941	0.80	0.50	0.86	339.52	36.43	0.32	36.74	1.01	340.69	1.46		1	100	1.00	1.00	340.7	0.88	Infin.	0.346	**Non-Liq.**	6.1	55.6	5.0	60.6	**0.03**	0.967	1,726	0.553	6.4E-04	1.7E-04	1.6E-04	0.002
25.59	7.80	416.69	3.00	0.72	39.90	115	1.471	1.471	0.940	0.72	0.50	0.85	332.78	35.66	0.23	35.89	1.01	333.96	1.44		1	100	1.00	1.00	334.0	0.88	Infin.	0.345	**Non-Liq.**	6.2	54.0	5.0	59.0	**0.03**	0.986	1,728	0.563	6.5E-04	1.8E-04	1.6E-04	0.002
26.08	7.95	468.27	4.07	0.87	44.84	115	1.500	1.500	0.938	0.87	0.50	0.84	370.55	40.26	0.39	40.65	1.01	371.74	1.47		1	100	1.00	1.00	371.7	0.87	Infin.	0.344	**Non-Liq.**	6.1	60.7	5.0	65.7	**0.03**	1.005	1,808	0.573	6.1E-04	1.5E-04	1.3E-04	0.002
26.57	8.10	527.12	5.14	0.98	50.48	115	1.528	1.528	0.936	0.98	0.50	0.83	413.37	45.41	0.50	45.91	1.01	414.57	1.48		1	100	1.00	1.00	414.6	0.86	Infin.	0.344	**Non-Liq.**	6.1	68.0	5.0	73.0	**0.02**	1.024	1,890	0.583	5.7E-04	1.2E-04	1.1E-04	0.001
27.07	8.25	431.08	4.31	1.00	41.28	115	1.556	1.556	0.934	1.00	0.50	0.82	334.73	36.81	0.53	37.34	1.01	335.94	1.54		1	100	1.00	1.00	335.9	0.86	Infin.	0.343	**Non-Liq.**	6.0	56.2	5.0	61.2	**0.03**	1.043	1,799	0.592	6.5E-04	1.7E-04	1.6E-04	0.002
27.56	8.40	448.56	3.66	0.82	42.95	115	1.585	1.585	0.932	0.82	0.50	0.82	345.20	37.75	0.33	38.08	1.01	346.43	1.47		1	100	1.00	1.00	346.4	0.85	Infin.	0.342	**Non-Liq.**	6.1	56.6	5.0	61.6	**0.03**	1.062	1,819	0.602	6.5E-04	1.7E-04	1.5E-04	0.002
28.05	8.55	523.42	3.72	0.71	50.12	115	1.613	1.613	0.930	0.71	0.50	0.81	399.45	43.66	0.22	43.88	1.01	400.68	1.38		1	100	1.00	1.00	400.7	0.84	Infin.	0.341	**Non-Liq.**	6.3	63.7	5.0	68.7	**0.03**	1.081	1,903	0.611	6.0E-04	1.4E-04	1.3E-04	0.001
28.54	8.70	442.10	3.80	0.86	42.34	115	1.641	1.641	0.928	0.86	0.50	0.80	334.25	36.89	0.38	37.27	1.01	335.50	1.49		1	100	1.00	1.00	335.5	0.84	Infin.	0.340	**Non-Liq.**	6.1	55.3	5.0	60.3	**0.03**	1.100	1,838	0.620	6.6E-04	1.8E-04	1.6E-04	0.002
29.04	8.85	373.11	4.30	1.15	35.73	115	1.670	1.670	0.925	1.16	0.50	0.80	279.41	31.31	0.69	32.00	1.02	280.67	1.64		1	100	1.00	1.00	280.0	0.83	Infin.	0.340	**Non-Liq.**	5.8	48.5	5.0	53.5	**0.04**	1.119	1,782	0.629	7.2E-04	2.2E-04	2.0E-04	0.002
29.53	9.00	360.25	4.62	1.28	34.50	115	1.698	1.698	0.923	1.29	0.51	0.78	265.64	30.23	0.82	31.05	1.03	266.90	1.69		1	100	1.03	1.00	275.5	0.83	Infin.	0.339	**Non-Liq.**	5.7	46.9	5.0	51.9	**0.04**	1.138	1,779	0.638	7.4E-04	2.4E-04	2.2E-04	0.003
30.02	9.15	481.54	4.35	0.90	46.11	115	1.726	1.726	0.920	0.91	0.50	0.78	355.06	39.77	0.42	40.19	1.01	356.33	1.49		1	100	1.00	1.00	356.3	0.82	Infin.	0.338	**Non-Liq.**	6.1	58.7	5.0	63.7	**0.03**	1.157	1,920	0.647	6.4E-04	1.6E-04	1.5E-04	0.002
30.51	9.30	584.43	4.47	0.76	55.96	115	1.754	1.754	0.918	0.77	0.50	0.78	427.67	47.82	0.28	48.09	1.01	428.96	1.39		1	100	1.00	1.00	429.0	0.82	Infin.	0.337	**Non-Liq.**	6.3	68.3	5.0	73.3	**0.02**	1.175	2,028	0.656	5.8E-04	1.2E-04	1.1E-04	0.001
31.00	9.45	612.47	5.03	0.82	58.65	115	1.783	1.783	0.915	0.82	0.50	0.77	444.67	50.18	0.34	50.51	1.01	445.96	1.40		1	100	1.00	1.00	446.0	0.81	Infin.	0.336	**Non-Liq.**	6.3	71.3	5.0	76.3	**0.02**	1.194	2,072	0.665	5.7E-04	1.1E-04	1.1E-04	0.001
31.50	9.60	540.29	5.06	0.94	51.74	115	1.811	1.811	0.913	0.94	0.50	0.76	389.01	44.25	0.46	44.71	1.01	390.32	1.48		1	100	1.00	1.00	390.3	0.81	Infin.	0.335	**Non-Liq.**	6.1	64.0	5.0	69.0	**0.03**	1.213	2,020	0.673	6.1E-04	1.4E-04	1.3E-04	0.001
31.99	9.75	499.33	4.59	0.92	47.82	115	1.839	1.839	0.910	0.92	0.50	0.76	356.63	40.56	0.44	41.00	1.01	357.94	1.50		1	100	1.00	1.00	357.9	0.80	Infin.	0.334	**Non-Liq.**	6.1	59.0	5.0	64.0	**0.03**	1.232	1,985	0.682	6.4E-04	1.6E-04	1.5E-04	0.002

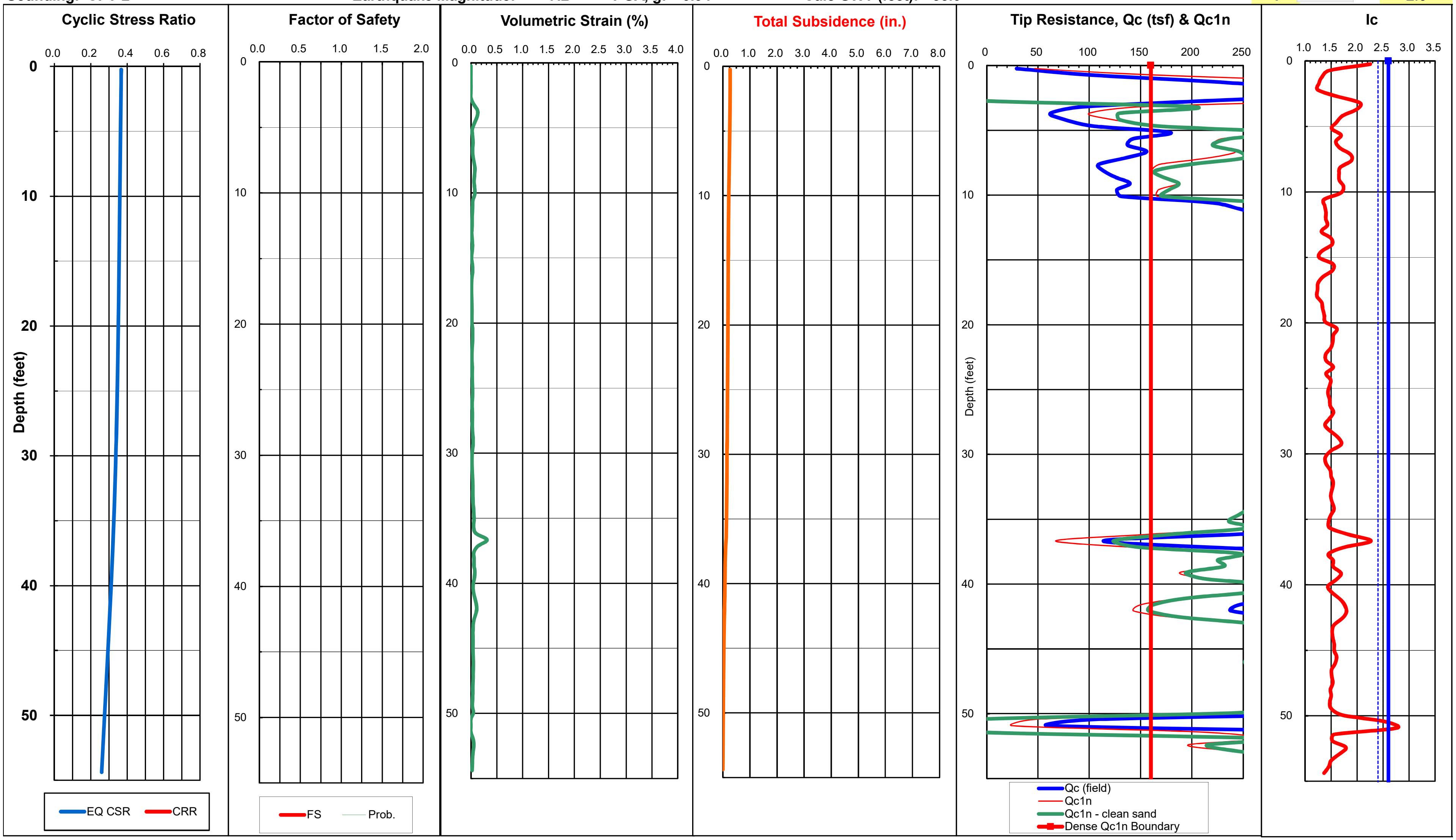
Depth (feet)	(m)	Tip Qc (tsf)	Friction Fs (tsf)	Friction Ratio Rf %	qc MPa	Total Unit Wt. (pcf)	Total Stress po (tsf)	Eff. Stress p'o (tsf)	rd	F %	n	Max 1.70 Cq	Q	Moss qc1 MPa	Moss Δqc MPa	Moss qc_{1mod} MPa	Moss eff K_C	Qc1n	Ic	Overide	Liquef. Suscept. (0 or 1)	Rel. Dens. Dr (%)	K_C	K_H	Clean Sand Qc1n	1.0 Kσ	CRR	Induced M=7.5 CSR	Liquefac. Safety Factor	Qc1n $N_{1(60)}$ Ratio	Equiv. $N_{1(60)}$	FC Adj. $\Delta N_{1(60)}$	Equiv. $N_{1(60)cs}$	***Volumetric Strain (%)***	p (tsf)	G_{max} (tsf)	τ_{av} (tsf)	Shear Strain γ	Strain E_{15}	Strain Enc	Dry Sand Subsidence (in.)
32.48	9.90	428.21	3.92	0.92	41.01	115	1.868	1.868	0.907	0.92	0.50	0.75	303.30	34.42	0.43	34.86	1.01	304.63	1.54		1	100	1.00	1.00	304.6	0.80	Infin.	0.333	**Non-Liq.**	6.0	51.0	5.0	56.0	**0.04**	1.251	1,913	0.690	7.1E-04	2.1E-04	1.9E-04	0.002
32.97	10.05	434.99	3.69	0.85	41.66	115	1.896	1.896	0.904	0.85	0.50	0.75	305.80	34.63	0.36	34.99	1.01	307.14	1.51		1	100	1.00	1.00	307.1	0.79	Infin.	0.332	**Non-Liq.**	6.0	50.9	5.0	55.9	**0.04**	1.270	1,926	0.698	7.1E-04	2.1E-04	1.9E-04	0.002
33.46	10.20	455.51	3.72	0.82	43.62	115	1.924	1.924	0.901	0.82	0.50	0.74	317.90	36.06	0.33	36.39	1.01	319.25	1.49		1	100	1.00	1.00	319.2	0.79	Infin.	0.331	**Non-Liq.**	6.1	52.5	5.0	57.5	**0.04**	1.289	1,959	0.706	6.9E-04	2.0E-04	1.8E-04	0.002
33.96	10.35	424.82	3.54	0.83	40.68	115	1.953	1.953	0.898	0.84	0.50	0.74	294.21	33.43	0.35	33.77	1.01	295.57	1.52		1	100	1.00	1.00	295.6	0.78	Infin.	0.329	**Non-Liq.**	6.0	49.1	5.0	54.1	**0.04**	1.308	1,933	0.714	7.3E-04	2.2E-04	2.0E-04	0.002
34.45	10.50	373.28	3.07	0.82	35.75	115	1.981	1.981	0.894	0.83	0.50	0.73	256.48	29.05	0.34	29.39	1.01	257.85	1.56		1	100	1.00	1.00	257.8	0.78	Infin.	0.328	**Non-Liq.**	6.0	43.3	5.0	48.3	**0.05**	1.327	1,876	0.722	7.9E-04	2.7E-04	2.5E-04	0.003
34.94	10.65	357.35	2.27	0.64	34.22	115	2.009	2.009	0.891	0.64	0.50	0.73	243.72	27.00	0.14	27.14	1.01	245.10	1.49		1	100	1.00	1.00	245.1	0.77	Infin.	0.327	**Non-Liq.**	6.1	40.3	5.0	45.3	**0.06**	1.346	1,849	0.729	8.2E-04	3.1E-04	2.8E-04	0.003
35.43	10.80	346.57	1.82	0.53	33.19	115	2.037	2.037	0.888	0.53	0.50	0.72	234.67	25.52	0.03	25.55	1.00	236.06	1.45		1	100	1.00	1.00	236.1	0.77	Infin.	0.326	**Non-Liq.**	6.2	38.3	5.0	43.3	**0.06**	1.365	1,834	0.737	8.5E-04	3.4E-04	3.1E-04	0.004
35.93	10.95	378.15	2.41	0.64	36.21	115	2.066	2.066	0.884	0.64	0.50	0.72	254.40	28.36	0.14	28.51	1.01	255.79	1.48		1	100	1.00	1.00	255.8	0.77	Infin.	0.324	**Non-Liq.**	6.1	41.9	5.0	46.9	**0.05**	1.384	1,897	0.744	8.0E-04	2.9E-04	2.6E-04	0.003
36.42	11.10	242.91	3.10	1.28	23.26	115	2.094	2.094	0.880	1.29	0.56	0.68	155.52	18.88	0.80	19.68	1.04	156.88	1.84		1	96	1.14	1.00	179.0	0.76	Infin.	0.323	**Non-Liq.**	5.4	29.1	5.0	34.1	**0.10**	1.403	1,717	0.751	1.0E-03	5.4E-04	5.0E-04	0.006
36.91	11.25	113.96	2.39	2.10	10.91	115	2.122	2.122	0.877	2.14	0.68	0.62	66.04	8.81	1.64	10.45	1.19	67.30	2.26		1	60	1.84	1.00	123.7	0.81	0.256	0.322	**Non-Liq.**	4.6	14.7	5.0	19.7	**0.31**	1.422	1,440	0.758	1.7E-03	1.7E-03	1.6E-03	0.018
37.40	11.40	213.79	1.64	0.77	20.47	115	2.151	2.151	0.873	0.77	0.53	0.69	137.75	15.62	0.27	15.89	1.02	139.15	1.73		1	91	1.06	1.00	147.4	0.75	0.378	0.320	**Non-Liq.**	5.6	24.8	4.7	29.5	**0.13**	1.441	1,658	0.765	1.1E-03	7.2E-04	6.6E-04	0.008
37.89	11.55	374.30	2.07	0.55	35.84	115	2.179	2.179	0.869	0.55	0.50	0.70	245.09	27.09	0.05	27.14	1.00	246.53	1.45		1	100	1.00	1.00	246.5	0.75	Infin.	0.319	**Non-Liq.**	6.2	40.0	5.0	45.0	**0.06**	1.460	1,921	0.771	8.2E-04	3.1E-04	2.8E-04	0.003
38.39	11.70	344.10	2.34	0.68	32.95	115	2.207	2.207	0.865	0.69	0.50	0.69	223.73	25.24	0.19	25.43	1.01	225.18	1.54		1	100	1.00	1.00	225.2	0.75	Infin.	0.317	**Non-Liq.**	6.0	37.6	5.0	42.6	**0.06**	1.479	1,899	0.778	8.5E-04	3.4E-04	3.1E-04	0.004
38.88	11.85	355.75	2.51	0.71	34.07	115	2.235	2.235	0.861	0.71	0.50	0.69	229.87	26.12	0.21	26.33	1.01	231.32	1.54		1	100	1.00	1.00	231.3	0.74	Infin.	0.316	**Non-Liq.**	6.0	38.7	5.0	43.7	**0.06**	1.498	1,927	0.784	8.3E-04	3.2E-04	3.0E-04	0.004
39.37	12.00	294.17	2.73	0.93	28.17	115	2.264	2.264	0.857	0.94	0.51	0.68	186.61	21.89	0.44	22.33	1.02	188.06	1.69		1	100	1.03	1.00	193.9	0.74	Infin.	0.314	**Non-Liq.**	5.7	33.1	5.0	38.1	**0.08**	1.517	1,852	0.790	9.1E-04	4.2E-04	3.9E-04	0.005
39.86	12.15	333.33	2.59	0.78	31.92	115	2.292	2.292	0.852	0.78	0.50	0.68	212.58	24.42	0.28	24.70	1.01	214.05	1.59		1	100	1.00	1.00	214.1	0.73	Infin.	0.313	**Non-Liq.**	5.9	36.4	5.0	41.4	**0.07**	1.536	1,917	0.796	8.5E-04	3.6E-04	3.3E-04	0.004
40.35	12.30	450.71	2.83	0.63	43.16	115	2.320	2.320	0.848	0.63	0.50	0.68	286.17	32.66	0.13	32.79	1.00	287.66	1.44		1	100	1.00	1.00	287.7	0.73	Infin.	0.311	**Non-Liq.**	6.2	46.5	5.0	51.5	**0.04**	1.555	2,074	0.801	7.3E-04	2.3E-04	2.2E-04	0.003
40.85	12.45	413.77	3.06	0.74	39.62	115	2.349	2.349	0.843	0.74	0.50	0.67	261.00	30.26	0.24	30.51	1.01	262.49	1.52		1	100	1.00	1.00	262.5	0.73	Infin.	0.310	**Non-Liq.**	6.0	43.5	5.0	48.5	**0.05**	1.574	2,046	0.807	7.5E-04	2.6E-04	2.4E-04	0.003
41.34	12.60	306.64	2.72	0.89	29.36	115	2.377	2.377	0.839	0.90	0.51	0.66	190.56	22.40	0.39	22.80	1.02	192.05	1.67		1	100	1.02	1.00	195.4	0.72	Infin.	0.308	**Non-Liq.**	5.7	33.5	5.0	38.5	**0.07**	1.593	1,905	0.812	8.9E-04	4.0E-04	3.7E-04	0.004
41.83	12.75	247.17	2.31	0.94	23.67	115	2.405	2.405	0.834	0.94	0.53	0.64	149.17	17.86	0.44	18.30	1.02	150.64	1.76		1	94	1.08	1.00	162.8	0.72	Infin.	0.306	**Non-Liq.**	5.5	27.2	5.0	32.2	**0.11**	1.612	1,805	0.817	1.0E-03	5.7E-04	5.3E-04	0.006
42.32	12.90	238.26	2.34	0.98	22.82	115	2.434	2.434	0.830	0.99	0.54	0.64	141.83	17.20	0.49	17.68	1.03	143.29	1.79		1	92	1.10	1.00	157.9	0.72	0.446	0.305	**Non-Liq.**	5.5	26.1	5.0	31.1	**0.11**	1.630	1,795	0.823	1.0E-03	6.1E-04	5.6E-04	0.007
42.81	13.05	298.99	2.88	0.96	28.63	115	2.462	2.462	0.825	0.97	0.52	0.64	180.68	21.75	0.47	22.21	1.02	182.19	1.71		1	100	1.05	1.00	190.5	0.71	Infin.	0.303	**Non-Liq.**	5.6	32.3	5.0	37.3	**0.08**	1.649	1,917	0.827	8.9E-04	4.2E-04	3.9E-04	0.005
43.31	13.20	420.64	3.47	0.82	40.28	115	2.490	2.490	0.820	0.83	0.50	0.65	257.62	30.57	0.33	30.89	1.01	259.15	1.56		1	100	1.00	1.00	259.2	0.71	Infin.	0.301	**Non-Liq.**	6.0	43.5	5.0	48.5	**0.05**	1.668	2,106	0.832	7.4E-04	2.5E-04	2.3E-04	0.003
43.80	13.35	465.24	3.75	0.81	44.55	115	2.518	2.518	0.816	0.81	0.50	0.65	283.47	33.79	0.31	34.09	1.01	285.01	1.52		1	100	1.00	1.00	285.0	0.71	Infin.	0.299	**Non-Liq.**	6.0	47.3	5.0	52.3	**0.04**	1.687	2,172	0.837	7.0E-04	2.2E-04	2.0E-04	0.002
44.29	13.50	472.39	3.97	0.84	45.24	115	2.547	2.547	0.811	0.85	0.50	0.64	286.23	34.38	0.34	34.72	1.01	287.78	1.53		1	100	1.00	1.00	287.8	0.70	Infin.	0.298	**Non-Liq.**	6.0	48.0	5.0	53.0	**0.04**	1.706	2,193	0.841	6.9E-04	2.1E-04	2.0E-04	0.002
44.78	13.65	458.31	4.07	0.89	43.89	115	2.575	2.575	0.806	0.89	0.50	0.64	276.10	33.39	0.39	33.78	1.01	277.66	1.56		1	100	1.00	1.00	277.7	0.70	Infin.	0.296	**Non-Liq.**	5.9	46.7	5.0	51.7	**0.04**	1.725	2,187	0.845	6.9E-04	2.2E-04	2.0E-04	0.002
45.28	13.80	462.89	4.13	0.89	44.33	115	2.603	2.603	0.801	0.90	0.50	0.64	277.34	33.65	0.39	34.04	1.01	278.91	1.56		1	100	1.00	1.00	278.9	0.70	Infin.	0.294	**Non-Liq.**	5.9	46.9	5.0	51.9	**0.04**	1.744	2,202	0.849	6.9E-04	2.2E-04	2.0E-04	0.002
45.77	13.95	434.52	4.19	0.96	41.61	115	2.632	2.632	0.796	0.97	0.50	0.63	258.83	31.64	0.46	32.10	1.01	260.41	1.60		1	100	1.00	1.00	260.4	0.69	Infin.	0.292	**Non-Liq.**	5.9	44.5	5.0	49.5	**0.04**	1.763	2,179	0.853	7.0E-04	2.4E-04	2.2E-04	0.003
46.26	14.10	421.93	3.59	0.85	40.40	115	2.660	2.660	0.791	0.86	0.50	0.63	249.93	30.13	0.35	30.48	1.01	251.51	1.57		1	100	1.00	1.00	251.5	0.69	Infin.	0.290	**Non-Liq.**	5.9	42.5	5.0	47.5	**0.05**	1.782	2,161	0.857	7.2E-04	2.5E-04	2.3E-04	0.003
46.75	14.25	436.64	3.09	0.71	41.81	115	2.688	2.688	0.786	0.71	0.50	0.63	257.31	30.44	0.20	30.64	1.01	258.91	1.51		1	100	1.00	1.00	258.9	0.69	Infin.	0.288	**Non-Liq.**	6.0	42.8	5.0	47.8	**0.05**	1.801	2,177	0.861	7.1E-04	2.5E-04	2.3E-04	0.003
47.24	14.40	448.68	3.28	0.73	42.97	115	2.717	2.717	0.781	0.73	0.50	0.62	263.06	31.35	0.23	31.58	1.01	264.66	1.51		1	100	1.00	1.00	264.7	0.69	Infin.	0.287	**Non-Liq.**	6.0	43.8	5.0	48.8	**0.04**	1.820	2,204	0.864	7.0E-04	2.4E-04	2.2E-04	0.003
47.74	14.55	457.48	3.61	0.79	43.81	115	2.745	2.745	0.776	0.79	0.50	0.62	266.84	32.21	0.29	32.50	1.01	268.45	1.53		1	100	1.00	1.00	268.5	0.68	Infin.	0.285	**Non-Liq.**	6.0	44.7	5.0	49.7	**0.04**	1.839	2,229	0.867	6.8E-04	2.3E-04	2.1E-04	0.002
48.23	14.70	511.00	3.87	0.76	48.93	115	2.773	2.773	0.771	0.76	0.50	0.62	296.71	35.93	0.25	36.18	1.01	298.33	1.49		1	100	1.00	1.00	298.3	0.68	Infin.	0.283	**Non-Liq.**	6.1	49.0	5.0	54.0	**0.04**	1.858	2,303	0.871	6.5E-04	2.0E-04	1.8E-04	0.002
48.72	14.85	501.91	3.87	0.77	48.06	115	2.801	2.801	0.766	0.78	0.50	0.61	289.91	35.21	0.27	35.47	1.01	291.53	1.50		1	100	1.00	1.00	291.5	0.68	Infin.	0.281	**Non-Liq.**	6.1	48.1	5.0	53.1	**0.04**	1.877	2,302	0.874	6.5E-04	2.0E-04	1.8E-04	0.002
49.21	15.00	551.14	4.26	0.77	52.78	115	2.830	2.830	0.761	0.78	0.50	0.61	316.89	38.78	0.27	39.04	1.01	318.53	1.47		1	100	1.00	1.00	318.5	0.67	Infin.	0.279	**Non-Liq.**	6.1	52.1	5.0	57.1	**0.03**	1.896	2,370	0.877	6.2E-04	1.7E-04	1.6E-04	0.002
49.70	15.15	581.26	5.11	0.88	55.66	115	2.858	2.858	0.756	0.88	0.50	0.61	332.63	41.56	0.37	41.93	1.01	334.27	1.50		1	100	1.00	1.00	334.3	0.67	Infin.	0.277	**Non-Liq.**	6.1	55.2	5.0	60.2	**0.03**	1.915	2,424	0.880	5.9E-04	1.6E-04	1.5E-04	0.002
50.20	15.30	408.07	4.90	1.20	39.08	115	2.886	2.886	0.751	1.21	0.52	0.59	227.19	29.53	0.68	30.21	1.02	228.81	1.71		1	100	1.05	1.00	239.5	0.67	Infin.	0.276	**Non-Liq.**	5.6	40.5	5.0	45.5	**0.05**	1.934	2,220	0.883	7.0E-04	2.6E-04	2.4E-04	0.003
50.69	15.45	104.12	3.53	3.39	9.97	115	2.915	2.915	0.746	3.49	0.74	0.47	44.98	7.61	2.80	10.40		46.27	2.53		0			1.00		0.82		0.274	**Non-Liq.**	4.0	11.4			**0.00**	1.953						
51.18	15.60	61.42	2.28	3.71	5.88	115	2.943	2.943	0.741	3.89	0.81	0.44	24.23	4.29	3.09	7.39		25.45	2.76		0			1.00		0.81		0.272	**Non-Liq.**	3.6	7.1			**0.00**	1.972						
51.67	15.75	372.77	2.49	0.67	35.70	115	2.971	2.971	0.736	0.67	0.50	0.60	208.57	24.72	0.16	24.88		211.04	1.56		0			1.00		0.81		0.270	**Non-Liq.**	6.0	35.5			**0.00**	1.991						
52.17	15.90	482.57	3.74	0.77	46.21	130	3.003	3.003	0.731	0.78	0.50	0.59	269.04	33.04	0.26	33.30	1.01	270.72	1.52		1	100	1.00	1.00	270.7	0.66	Infin.	0.268	**Non-Liq.**	6.0	45.0	5.0	50.0	**0.04**	2.012	2,336	0.894	6.4E-04	2.1E-04	2.0E-04	0.002
52.66	16.05	366.45	4.74	1.29	35.09	130	3.035	3.035	0.726	1.30	0.54	0.57	194.60	26.20	0.76	26.96	1.03	196.22	1.78		1	100	1.09	1.00	214.7	0.66	Infin.	0.266	**Non-Liq.**	5.5	35.6	5.0	40.6	**0.06**	2.034	2,191	0.898	7.2E-04	3.1E-04	2.8E-04	0.003
53.15	16.20	439.58	4.78	1.09	42.09	130	3.067	3.067	0.721	1.09	0.51	0.58	240.58	31.05	0.56	31.61	1.02	242.27	1.66		1	100	1.01	1.00	245.6	0.65	Infin.	0.265	**Non-Liq.**	5.7	42.2	5.0	47.2	**0.04**	2.055	2,316	0.901	6.5E-04	2.3E-04	2.2E-04	0.003
53.64	16.35	547.08	4.41	0.81	52.39	130	3.099	3.099	0.716	0.81	0.50	0.58	300.41	37.61	0.29	37.90	1.01	302.12	1.50		1	100	1.00	1.00	302.1	0.65	Infin.	0.263	**Non-Liq.**	6.1	49.9	5.0	54.9	**0.03**	2.076	2,448	0.904	6.0E-04	1.8E-04	1.6E-04	0.002
54.13	16.50	609.06	4.63	0.76	58.32	130	3.131	3.131	0.712	0.76	0.50	0.58	332.91	41.70	0.25	41.95	1.01	334.63	1.45		1	100	1.00	1.00	334.6	0.65	Infin.	0.261	**Non-Liq.**	6.1	54.4	5.0	59.4	**0.03**	2.098	2,526	0.908	5.7E-04	1.5E-04	1.4E-04	0.002
54.63	16.65	674.32	4.22	0.63	64.57	130	3.163	3.163	0.707	0.63	0.50	0.58	366.88	45.06	0.12	45.18	1.00	368.61	1.36		1	100	1.00	1.00	368.6	0.65	Infin.	0.259	**Non-Liq.**	6.3	58.2	5.0	63.2	**0.03**	2.119	2,593	0.911	5.4E-04	1.4E-04	1.3E-04	0.001

EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

Rio Mesa High School Bleachers **Project No: 303280-002** Method Used: 1 1998 NCEER (Robertson & Wride)

Settlement Analysis using Tokimatsu & Seed (1987), clean sand Qc1n/N1(60) ratio =5

Sounding: CPT-2 **Earthquake Magnitude: 7.2** **PGA, g: 0.94** **Calc GWT (feet): 55.0** Plot 1 Limiting Ic: 2.6



Total Thickness of Liquefiable Layers: 0.0 feet **Estimated Total Ground Subsidence (Settlement): 0.3 inches**

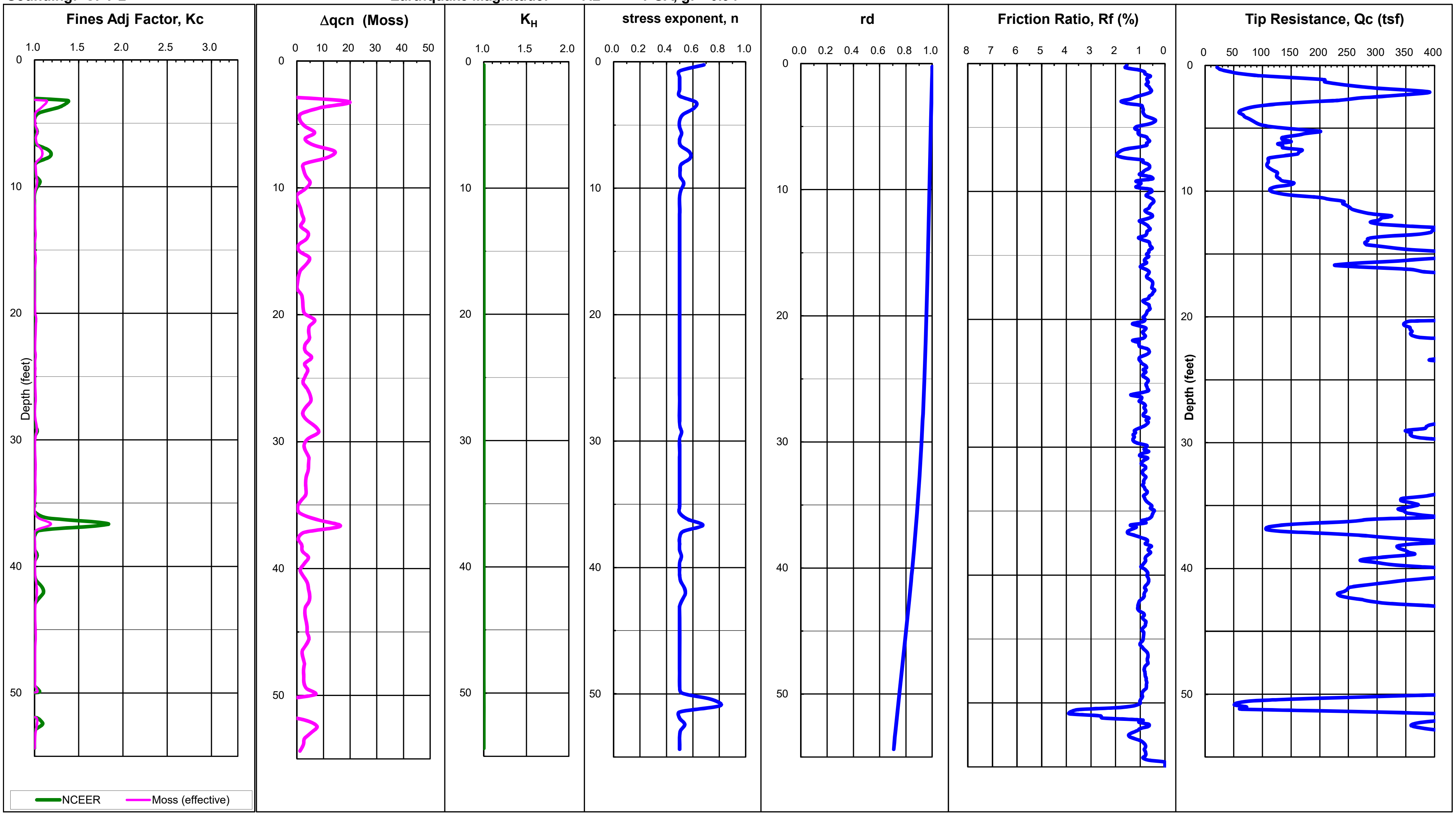
EARTH SYSTEMS - EVALUATION OF LIQUEFACTION POTENTIAL AND INDUCED GROUND SUBSIDENCE

3 avg increment =0.15m Qc1n/N1(60): 5

Ignore 1st/last increment into sand/silt soils: 0

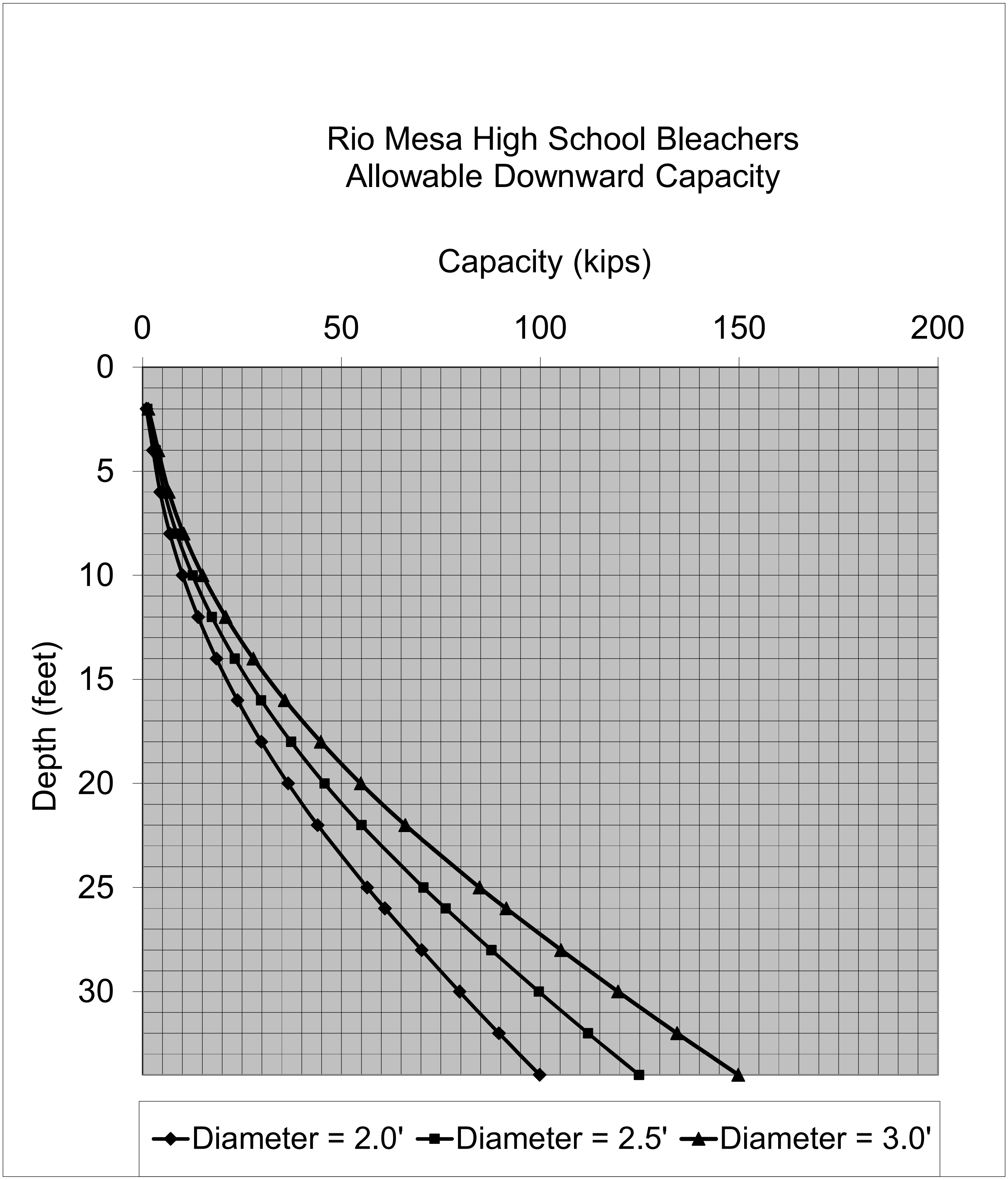
Method Used: 1998 NCEER (Robertson & Wride)

Sounding: CPT-2 **Earthquake Magnitude: 7.2** **PGA, g: 0.94**

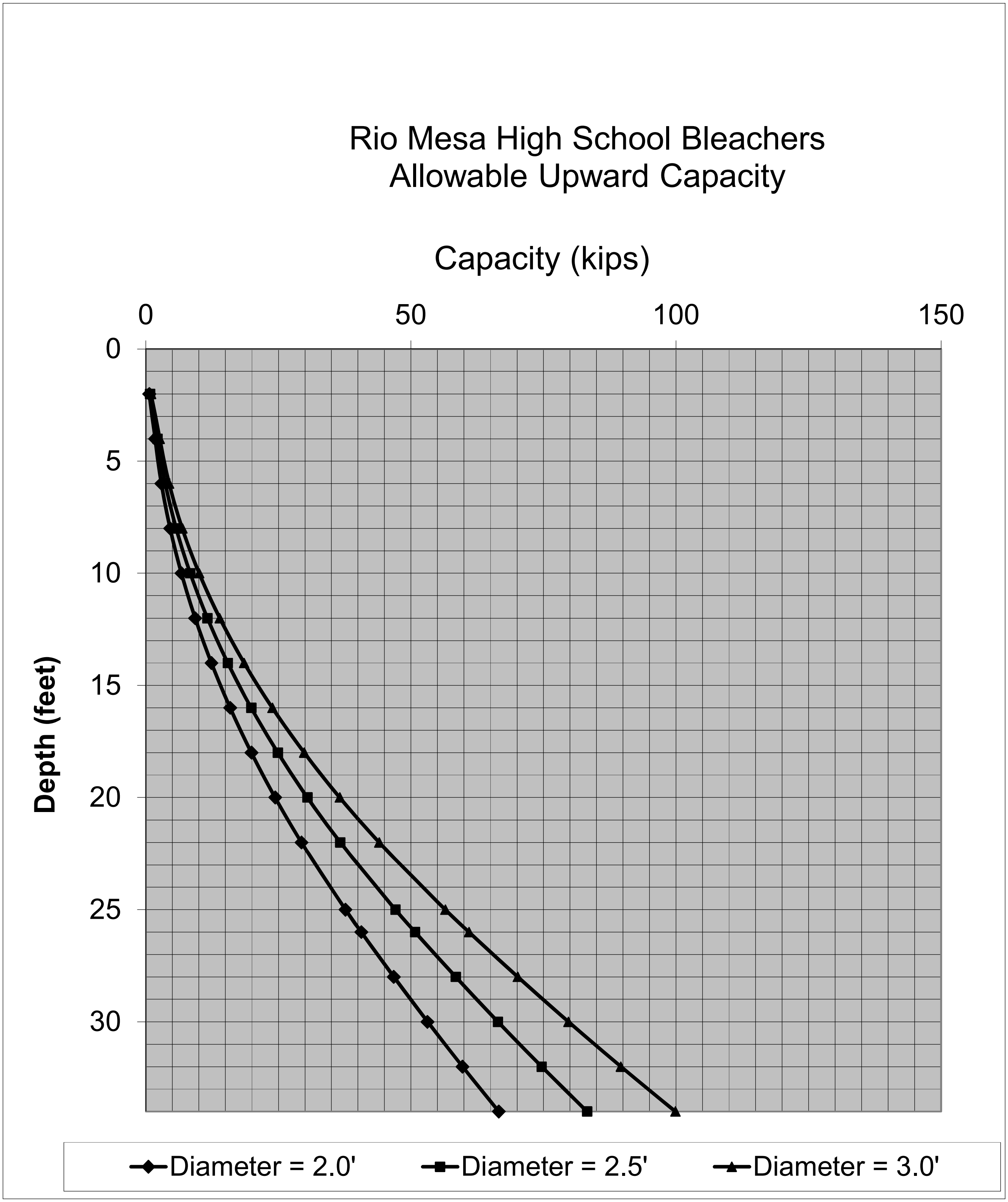


APPENDIX E

Pile Capacity Graphs



Rio Mesa High School Bleachers
Allowable Downward Capacity
Capacity (kips)
0
50
100
150
200
0
5
10
15
20
25
30
Depth (feet)
Diameter = 2.0'
Diameter = 2.5'
Diameter = 3.0'



Rio Mesa High School Bleachers
Allowable Upward Capacity
Capacity (kips)
0
50
100
150
0
5
10
15
20
25
30
Depth (feet)
Diameter = 2.0'
Diameter = 2.5'
Diameter = 3.0'