CORNERSTONE
EARTH GROUP

TYPE OF SERVICES	Geotechnical Investigation
PROJECT NAME	Center Street Residential Development
LOCATION	130-132 Center Street Santa Cruz, California
CLIENT	Swenson
PROJECT NUMBER	100-65-1
DATE	September 11, 2020


GEOTECHNICAL

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Location 130-132 Center Street
Santa Cruz, California
Client Swenson
Client Address 777 North First Street, 5th Floor
San Jose, CA
Project Number 100-65-1
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TABLE OF CONTENTS

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SECTION 1: INTRODUCTION

This geotechnical report was prepared for the sole use of Swenson for the Center Street Residential Development in Santa Cruz, California. The location of the site is shown on the Vicinity Map, Figure 1. For our use, we were provided with the following documents:

- A set of schematic plans titled “130 Center St., Santa Cruz” prepared by Swenson, dated March 3, 2020.

1.1 PROJECT DESCRIPTION

The planned development will be five stories with one level of below-grade parking with a partial stacker pit. The building will include one level of concrete podium above grade and four levels of Type V wood-frame residential construction above the podium. The planned development will have a footprint of approximately 51,000 square feet. Appurtenant parking, utilities, landscaping and other improvements necessary for site development are also planned.

Structural loads are not yet finalized for the proposed structure; however, structural loads are expected to be typical of similar type structures. The structural engineer estimated an average dead plus live foundation pressure at the basement level to be approximately 1,800 pounds per square feet (psf). Grading will consist of cuts up to 15 feet deep for the planned basement excavation.

1.2 SCOPE OF SERVICES

Our scope of services was presented in our proposal dated June 19, 2020 and consisted of field and laboratory programs to evaluate physical and engineering properties of the subsurface soils, engineering analysis to prepare recommendations for site work and grading, building foundations, flatwork, retaining walls, and pavements, and preparation of this report. Brief descriptions of our exploration and laboratory programs are presented below.

1.3 EXPLORATION PROGRAM

Field exploration consisted of two borings drilled on July 20, 2020 with truck-mounted, hollow-stem auger rotary-wash drilling equipment and five Cone Penetration Tests (CPTs) advanced on July 9 and 10, 2020. The borings were drilled to depths of 50 to 75 feet; the CPTs were advanced to depths of 50 to 100 feet. Seismic shear wave velocity measurements were collected from all CPTs. Boring EB-1 and EB-2 were advanced adjacent to CPT-1 and CPT-5, respectively, for direct evaluation of physical samples to correlated soil behavior. The borings and CPTs were backfilled with cement grout in accordance with local requirements; exploration permits were obtained as required by local jurisdictions.

The approximate locations of our exploratory borings are shown on the Site Plan, Figure 2. Details regarding our field program are included in Appendix A.

1.4 LABORATORY TESTING PROGRAM

In addition to visual classification of samples, the laboratory program focused on obtaining data for foundation design and seismic ground deformation estimates. Testing included moisture contents, dry densities, grain size analyses, washed sieve analyses, one-dimensional consolidation tests, and Plasticity Index tests. Details regarding our laboratory program are included in Appendix B.

1.5 CORROSION EVALUATION

Three samples from our borings from depths from 3½ to 9 feet were tested for saturated resistivity, pH, and soluble sulfates and chlorides. JDH Corrosion Consultants prepared a brief corrosion evaluation based on the laboratory data, which is attached to this report in Appendix C.

1.6 ENVIRONMENTAL SERVICES

Environmental services were not requested for this project. If environmental concerns are determined to be present during future evaluations, the project environmental consultant should review our geotechnical recommendations for compatibility with the environmental concerns.

SECTION 2: REGIONAL SETTING

The San Francisco Bay area region is one of the most seismically active areas in the Country. While seismologists cannot predict earthquake events, the U.S. Geological Survey's Working Group on California Earthquake Probabilities 2015 revises earlier estimates from their 2008 (2008, UCERF2) publication. Compared to the previous assessment issued in 2008, the estimated rate of earthquakes around magnitude 6.7 (the size of the destructive 1994 Northridge earthquake) has gone down by about 30 percent. The expected frequency of such events statewide has dropped from an average of one per 4.8 years to about one per 6.3 years. However, in the new study, the estimate for the likelihood that California will experience a magnitude 8 or larger earthquake in the next 30 years has increased from about 4.7 percent for UCERF2 to about 7.0 percent for UCERF3.

UCERF3 estimates that each region of California will experience a magnitude 6.7 or larger earthquake in the next 30 years. Additionally, there is a 63 percent chance of at least one magnitude 6.7 or greater earthquake occurring in the Bay Area region between 2007 and 2036.

The faults considered capable of generating significant earthquakes are generally associated with the well-defined areas of crustal movement, which trend northwesterly. The table below presents the State-considered active faults within 25 kilometers of the site.

Table 1: Approximate Fault Distances

Fault Name	Distance	
	(miles)	(kilometers)
Zayante Vergeles	8.4	13.5
San Gregorio	10.8	17.4
San Andreas	11.5	18.6

A regional fault map is presented as Figure 3, illustrating the relative distances of the site to significant fault zones.

SECTION 3: SITE CONDITIONS

3.1 SURFACE DESCRIPTION

The site is comprised of two parcels located at 130 and 132 Center Street in Santa Cruz. The parcels are bounded by Center Street to the west and existing commercial and residential development to the north, east and south. Currently, the site is occupied by two one-story commercial buildings that are surrounded by asphalt concrete parking.

From historic aerials, the north building, which is currently a rental car establishment, is shown to be on the property since 1968. The southern building, which is currently an auto body shop, is also shown to be on the site since 1968. Prior to that and reviewing aerial photos dating back to 1952, the entire area was a vacant lot with vegetation growing in various areas.

Surface pavements generally consisted of 1 inch of asphalt concrete over 3 inches of aggregate base. Based on visual observations, the existing pavements are in fair shape with distress and cracking. Minor landscaping was observed along the western edge of the site.

3.2 SUBSURFACE CONDITIONS

Boring EB-1 and CPT-1, drilled adjacent to each other, encountered stiff lean clays to 7½ feet underlain by soft clay to a depth of 11½ feet. At this location, the upper clay is underlain by interbedded layers of medium stiff to soft silts and loose silty sand to a depth of approximately

26 feet. These silt/sand layers are underlain by a thin medium stiff lean clay layer to 27½ feet. Below this depth, Boring EB-1 encountered medium dense silty to poorly-graded sands to a depth of about 36½ feet. The sands were followed by medium stiff lean clay to a depth of about 48 feet and by medium stiff to stiff, low plasticity silt to a depth of 56½ feet. The deeper clays and silts were followed by medium dense silty sands and poorly graded sands down to the maximum depth explored of 75 feet in Boring EB-1.

Below the surface pavement, EB-2 and the remaining CPTs encountered soft to stiff lean clays and medium stiff silt to a depth of approximately 45½ feet. The upper clay and silt layers are underlain by medium dense to dense sands to the maximum depth explored at 100 feet in CPT-5. A generalized cross section (A-A′) depicting the subsurface conditions is presented in Figure 4.

Below the surface pavements, Boring EB-1 encountered undocumented fill consisting of stiff sandy lean clay to a depth of approximately 3 feet. No fill was encountered in Boring EB-2.

3.2.1 Plasticity/Expansion Potential

We performed six Plasticity Index (PI) tests on representative samples. Test results were used to evaluate expansion potential of surficial soils and the plasticity of the fines in potentially liquefiable layers. The results of the surficial PI tests indicated PIs ranged from non-plastic to 19, indicating low to moderate plasticity and expansion potential to wetting and drying cycles.

3.2.2 In-Situ Moisture Contents

Laboratory testing indicated that the in-situ moisture contents within the upper 15 feet range from about 5 to 25 percent over the estimated laboratory optimum moisture.

3.3 GROUNDWATER

Groundwater was encountered in Boring EB-1 at a depth of approximately 8 feet prior to switching to rotary wash drilling methods. Ground water was not encountered in Boring EB-2. Pore pressure measurements from CPT-1, CPT-3, and CPT-5 inferred ground water at depths ranging from 3 to 8 feet below current grades. We estimate that the ground depth inferred in CPT-3 at a depth of 3 feet may have been recorded in a deeper water bearing zone that was confined and not representative of the shallow water bearing zone. Groundwater level measurements reviewed from the website GeoTracker (geotracker.com) indicated groundwater depths at nearby sites are shown to be as shallow as approximately 6½ feet below existing grades in 2005. All measurements were taken at the time of drilling and may not represent the stabilized levels that can be higher than the initial levels encountered. For our liquefaction analysis, we assumed a design groundwater depth of 5 feet below current site grades.

Fluctuations in ground water levels occur due to many factors including seasonal fluctuation, underground drainage patterns, regional fluctuations, and other factors.

SECTION 4: GEOLOGIC HAZARDS

4.1 FAULT RUPTURE

As discussed above several significant faults are located within 25 kilometers of the site. The site is not located within a State-designated Alquist Priolo Earthquake Fault Zone. As shown in Figure 3, no known surface expression of fault traces is thought to cross the site; therefore, fault rupture hazard is not a significant geologic hazard at the site.

4.2 ESTIMATED GROUND SHAKING

Moderate to severe (design-level) earthquakes can cause strong ground shaking, which is the case for most sites within the Bay Area. A peak ground acceleration (PGA_M) was estimated following the Site Specific Response analysis procedure presented in Chapter 21, Section 21.1 of ASCE 7-16 and Supplement No.1.

4.3 LIQUEFACTION POTENTIAL

The site is not currently mapped by the State of California but is within zones mapped as having a high liquefaction potential by the Association of Bay Area Governments (ABAG, 2020). Therefore, our field and laboratory programs addressed this issue by testing and sampling potentially liquefiable layers to depths of at least 50 feet, performing visual classification on sampled materials, evaluating CPT data, and performing various laboratory tests to further classify soil properties.

During strong seismic shaking, cyclically induced stresses can cause increased pore pressures within the soil matrix that can result in liquefaction triggering, soil softening due to shear stress loss, potentially significant ground deformation due to settlement within sandy liquefiable layers as pore pressures dissipate, and/or flow failures in sloping ground or where open faces are present (lateral spreading) (NCEER 1998). Limited field and laboratory data are available regarding ground deformation due to settlement; however, in clean sand layers settlement on the order of 2 to 4 percent of the liquefied layer thickness can occur. Soils most susceptible to liquefaction are loose, non-cohesive soils that are saturated and are bedded with poor drainage, such as sand and silt layers bedded with a cohesive cap.

Our preliminary analysis was performed in accordance with widespread geotechnical practice that was based on the use of simplified methods for evaluating liquefaction, settlement and lateral spreading which had been taught by academics for the previous 35 years. While it was generally known that these simplified methods of analysis are very approximate, it was also thought that they were usually conservative and very little has changed in the methodology in the past 20 or so years. This methodology is still in wide-spread use in practice today. There was surprisingly little discussion in the literature about the degree of conservatism of these simplified methods of analysis, although Semple (2013), Pyke (2015), Boulanger et al. (2016), and Pyke and North (2019) provide good summaries of the issues and references to earlier work.

Based on the results of the simplified analyses, we concluded that these simplified methods of analysis may be too approximate on projects where a significant amount of liquefaction potential and settlement is predicted using the accepted simplified methods and that it is necessary to conduct nonlinear effective stress site response analyses in order to both understand the case histories of liquefaction, settlement and lateral spreading in order to make forward predictions of performance at sites such as this project with sufficient accuracy. Recent geotechnical literature Ntritsos et al. (2018), Crawford et al. (2019), Cubrinovski (2019), Hutabarat and Bray (2019), Kramer (2019), Pyke (2019) and Olson et al. (2020) provides detailed discussions on the use of more robust nonlinear effective stress site response analysis.

The nonlinear effective stress analyses were conducted by our technical partner Dr. Robert Pyke, PhD, G.E. using his program TESS2, which has been used on recent projects with initially large-predicted liquefaction settlement and ground improvement costs including River Islands and Thornton Middle School. A detailed discussion of our liquefaction assessment for the project site is presented in Dr. Pyke’s report that is attached to this report as Appendix D. While the site geologic history and absence of historical observation of liquefaction indicate there is qualitative low to very low potential for liquefaction, we performed the nonlinear effective stress analyses to quantitively evaluate to liquefaction potential and settlement consistent with current engineering practice to perform quantitative liquefaction analyses. We note that multiple TESS2 runs were preformed using 5 earthquake time histories as input motions in the soil models. The results of our analyses indicated the potential for liquefaction is low to moderate and that if liquefaction were to occur, the consequences of liquefaction for the planned structure is that seismic settlements would be on the order of 2 to 2½ inches in the vicinity of Boring EB-1 and CPT-1 and less than 1 inch across the remainder of the site. Further discussion of the non-linear effective stress analysis and liquefaction and seismic settlement evaluation are presented in Appendix D.

4.3.3 Summary

Our non-linear analyses indicate that several layers could potentially experience liquefaction triggering that could result in soil softening and post-liquefaction total settlement ranging from approximately 2 to 2½ inches in the vicinity of EB-1/CPT-1. Estimated settlement at the remaining exploration locations was less than 1 inch. As discussed in SP 117A, differential movement for level ground sites over deep soil sites will be up to about two-thirds of the total settlement. In our opinion, differential settlements are anticipated to be on the order of 1 to 1½ inches between independent foundation elements or over a horizontal distance of 30 feet along continuous foundations. To mitigate the liquefaction settlement, we recommend that building be supported on a rigid mat foundation designed to tolerate the anticipated differential settlement. If it is not feasible to design a mat to efficiently tolerate seismic settlement, ground improvement consisting of drilled displacement columns or other methods could be considered. Further discussion is presented in the “Conclusions” section of this report.

4.3.4 Ground Rupture Potential

The methods used to estimate liquefaction settlements assume that there is a sufficient cap of non-liquefiable material to prevent ground rupture or sand boils. For ground rupture to occur, the pore water pressure within the liquefiable soil layer will need to be great enough to break through the overlying non-liquefiable layer, which could cause significant ground deformation and settlement. The work of Youd and Garris (1995) indicates that the non-liquefiable cap is sufficient to prevent ground rupture in at-grade buildings areas; however, ground rupture is theoretically possible at the basement level in the vicinity of EB-1/CPT-1. If a rigid mat foundation is used for the project, in our opinion, the potential for ground rupture to vent would be low due to the constraint provided by a continuous mat.

4.4 LATERAL SPREADING

Lateral spreading is horizontal/lateral ground movement of relatively flat-lying soil deposits towards a free face such as an excavation, channel, or open body of water; typically lateral spreading is associated with liquefaction of one or more subsurface layers near the bottom of the exposed slope. As failure tends to propagate as block failures, it is difficult to analyze and estimate where the first tension crack will form.

The site is approximately 1,300 feet from the nearby San Lorenzo River. The channel bottom is estimated to be approximately 10 to 15 feet deep relative to existing site grades. As part of our liquefaction analyses, we calculated the Lateral Displacement Index (LDI) for potentially liquefiable layers based on methods presented in the 2008 monograph, *Soil Liquefaction During Earthquakes* (Idriss and Boulanger, 2008). LDI is a summation of the maximum shear strains versus depth, which is a measurement of the potential maximum displacement at that exploration location. Summations of the LDI values to a depth equal to twice the open face height were included. Theoretical displacements in the site vicinity based on the LDI calculations are on the order of 6 to 18 inches.

However, since the proposed building will likely be supported on a rigid mat foundation embedded at least one level below grade, and the site is underlain by variable, discontinuous layers of potentially liquefiable soils, and is at least 1,300 feet from the river, in our opinion, the potential for lateral spreading to impact the project is considered relatively low.

4.5 SEISMIC SETTLEMENT/UNSATURATED SAND SHAKING

Loose unsaturated sandy soils can settle during strong seismic shaking. As the soils encountered above the groundwater level at the site were predominantly stiff to very stiff clays, in our opinion, the potential for significant differential seismic settlement affecting the proposed improvements is low.

4.6 TSUNAMI/SEICHE

The terms tsunami or seiche are described as ocean waves or similar waves usually created by undersea fault movement or by a coastal or submerged landslide. Tsunamis may be generated at great distance from shore (far field events) or nearby (near field events). Waves are formed, as the displaced water moves to regain equilibrium, and radiates across the open water, similar to ripples from a rock being thrown into a pond. When the waveform reaches the coastline, it quickly raises the water level, with water velocities as high as 15 to 20 knots. The water mass, as well as vessels, vehicles, or other objects in its path create tremendous forces as they impact coastal structures.

Tsunamis have affected the coastline along the Pacific Northwest during historic times. The Fort Point tide gauge in San Francisco recorded approximately 21 tsunamis between 1854 and 1964. The 1964 Alaska earthquake generated a recorded wave height of 7.4 feet and drowned eleven people in Crescent City, California. For the case of a far-field event, the Bay area would have hours of warning; for a near field event, there may be only a few minutes of warning, if any.

A tsunami or seiche originating in the Pacific Ocean would lose some of its energy passing around the northern tip of the Monterey bay. The site is approximately 1/3 mile inland from the Pacific Ocean shoreline, is mapped by the California Geologic Survey as being within a tsunami inundation area (CGS, 2009), and is approximately 13 to 16 feet above mean sea level. Therefore, the potential for inundation due to tsunami or seiche is considered moderate.

4.7 FLOODING

Based on our internet search of the Federal Emergency Management Agency (FEMA) flood map public database, the site is located within Zone A99 determined as special flood hazard areas, without case flood elevation. We recommend the project civil engineer be retained to confirm this information and verify the base flood elevation, if appropriate.

SECTION 5: CONCLUSIONS

5.1 SUMMARY

From a geotechnical viewpoint, the project is feasible provided the concerns listed below are addressed in the project design. Descriptions of each concern with brief outlines of our recommendations follow the listed concerns.

- Potential for seismic and static settlements
- Shallow ground water
- Shoring considerations for below-grade excavations
- Differential movement at on-grade to on-structure transitions
- Soil corrosion potential

5.1.1 Potential Seismic and Static Settlements

Our liquefaction analysis indicates that there is a high potential for liquefaction of localized sand layers during a significant seismic event. Our analysis indicates that liquefaction-induced settlement on the order of approximately 2 to 2½ inches could occur in the vicinity of Boring EB-1/CPT-1 near the northeast portion of the site, resulting in differential settlement up to 1 to 1½ inches. Liquefaction induced settlement across the remainder of the site is estimated to be less than 1 inch.

In addition to liquefaction induced settlement, our static settlement analysis indicates a total settlement due to an average foundation contact pressure of 1,800 psf would be approximately ½ to ¾ inch. We anticipate that approximately 25 to 30 percent of the settlement would occur during construction, therefore, approximately ¼ inch of differential settlement is anticipated between adjacent foundation elements.

To mitigate potential impacts due to combined total and differential settlement, we recommend the structure be supported on a rigid mat foundation design to tolerate anticipated settlement. If it is determined that a rigid mat foundation is not feasible, ground improvement can be considered to reduce differential settlement. Recommendations are presented in the "Foundations" sections of this report.

5.1.2 Shallow Groundwater

Shallow groundwater was measured at a depth of approximately 8 feet below the existing ground surface. Based on historical data from nearby sites, a design groundwater level of 5 feet should be used for design. Our experience with similar sites in the vicinity indicates that shallow ground water could significantly impact grading and underground construction. These impacts typically consist of potentially wet and unstable basement subgrade, difficulty achieving compaction, and difficult underground utility installation. Dewatering and shoring of utility trenches may be required in some isolated areas of the site. Detailed recommendations addressing this concern are presented in the "Earthwork" section of this report.

5.1.3 Shoring and Underpinning Considerations

For a one level below-grade basement, an approximately 15 feet deep excavation will likely be required for the mat foundation excavation. Locally deeper excavations will be required if auto stacker pits are considered. The adjacent buildings, sidewalks, streets and utilities along the sides of the site should be supported by temporary shoring until the permanent basement walls have been constructed. The primary considerations in selecting a suitable shoring system typically include 1) control of vertical and lateral ground surface or wall movements, 2) constructability, 3) dewatering and 4) cost. There are several possible methods of providing lateral support for the excavation, including a soldier pile and lagging retaining system, soldier pile tremie concrete (SPTC) walls or mixed-in-place soil/cement walls.

All systems would require tiebacks or internal bracing for lateral support. A soldier pile and lagging retaining system is more flexible and pervious than either an SPTC or mixed-in-place soil/cement wall. The latter two types of walls would be relatively rigid and could significantly limit lateral deflections and ground movement related to the shoring. In addition, SPTC or mixed-in-place soil/cement walls are relatively impervious and would reduce the volume of water pumped to dewater the site. The disadvantages of these systems are cost and space requirements, as they may require 2 to 3 feet around the perimeter of the site. A combination of these systems could be used depending on the performance desired along the various excavation faces. For example, portions of the north and east basement walls may encounter more permeable silt and sand layers that may be susceptible to sloughing or caving and would likely require greater volume of groundwater pumping. Where movements could be detrimental to adjacent existing buildings/improvements or it is not practical to install underpinning, the stiffer shoring systems could be used. The shoring system selected should be designed by a shoring designer or structural engineer experienced in the specific type of construction.

If the excavation extends below the level of an adjacent building foundation, lateral support should be provided to prevent loss of ground beneath existing slab-on-grade floors. Where adjacent foundations are above an imaginary 1:1 (horizontal to vertical) line extending up from the base of the excavation, they should be underpinned unless the shoring can be designed to provide lateral and/or vertical support for the structure. Additional design and construction considerations for the shoring system include the following items:

1. Soldier pile and lagging wall below the groundwater may experience difficulties with seepage, localized flowing sand and possible increased wall movement.
2. Adjacent structures may need to be underpinned to protect from ground movement associated with the proposed shoring system. Slant piles will likely be an acceptable method to underpin adjacent structures, although other methods are available. Underpinning will likely need to extend into competent soil below the excavation level.
3. The shoring will need to extend deep enough to reduce the potential for base heave, groundwater piping, and/or bearing failure.
4. Tie-backs in the upper loose to medium dense sands along the north and east walls will likely require a smooth-cased tieback method and pressure grouting to develop sufficient bond strengths.
5. Internal bracing may be required in areas where tie-back encroachment is not feasible or allowed by adjacent property owners.
6. The contractor should establish survey points on the shoring and on adjacent improvements within 25 feet of the excavation perimeter prior to the start of excavation. These survey points should be used to monitor the vertical and horizontal movements of the shoring and surrounding improvements during construction. In addition, a thorough crack survey of the adjacent buildings should be performed by the project surveyor prior to the start of construction and immediately after its completion.

Recommendations for design of temporary shoring, tie-back anchors, dewatering and underpinning are presented in the following sections of this report.

5.1.4 Differential Movement at On-grade to On-Structure Transitions

Some of the development area and other improvements will transition from on-grade support to overlying the basements. Where basement walls extend to within inches of finished grade, these transition areas typically experience increased differential movement due to a variety of causes, including difficulty in achieving compaction of retaining wall backfill closest to the wall. We recommend consideration be given to where engineered fill is placed behind retaining walls extending to near finished grade, and that subslabs be included beneath flatwork or pavers that can cantilever at least 3 feet beyond the wall. If surface improvements are included that are highly sensitive to differential movement, additional measures may be necessary. We also recommend that retaining wall backfill be compacted to 95 percent where surface improvements are planned (see “Retaining Wall” section).

5.1.5 Soil Corrosion Potential

A preliminary soil corrosion screening was performed by JDH Corrosion Consultants based on the results of analytical tests on samples of the near-surface soil. In general, the JDH report concludes that the corrosion potential for buried concrete is low and therefore no cement-type restrictions are required for buried concrete. However, the corrosion potential for buried metallic structures, such as metal pipes, is considered corrosive to moderately corrosive. Based on the results of the preliminary soil corrosion screening, special requirements for corrosion control will likely be required to protect metal pipes and fittings. We recommend a corrosion engineer be engaged to provide recommendations for corrosion protection of metal pipes, if used on this project. A more detailed discussion of the site corrosion evaluation is presented in Appendix C.

5.2 PLANS AND SPECIFICATIONS REVIEW

We recommend that we be retained to review the geotechnical aspects of the project structural, civil, and landscape plans and specifications, allowing sufficient time to provide the design team with any comments prior to issuing the plans for construction.

5.3 CONSTRUCTION OBSERVATION AND TESTING

As site conditions may vary significantly between the small-diameter borings performed during this investigation, we also recommend that a Cornerstone representative be present to provide geotechnical observation and testing during earthwork and foundation construction. This will allow us to form an opinion and prepare a letter at the end of construction regarding contractor compliance with project plans and specifications, and with the recommendations in our report. We will also be allowed to evaluate any conditions differing from those encountered during our investigation and provide supplemental recommendations as necessary. For these reasons, the recommendations in this report are contingent of Cornerstone providing observation and testing during construction. Contractors should provide at least a 48-hour notice when scheduling our field personnel.

SECTION 6: EARTHWORK

6.1 SITE DEMOLITION, CLEARING AND PREPARATION

6.1.1 Site Stripping

The site should be stripped of all surface vegetation, and surface and subsurface improvements within the proposed development area. Demolition of existing improvements is discussed in detail below. A detailed discussion of removal of existing fills is provided later in this report. Surface vegetation and topsoil should be stripped to a sufficient depth to remove all material greater than 3 percent organic content by weight.

6.1.2 Tree and Shrub Removal

Trees and shrubs designated for removal should have the root balls and any roots greater than ½-inch diameter removed completely. Mature trees are estimated to have root balls extending to depths of 2 to 4 feet, depending on the tree size. Significant root zones are anticipated to extend to the diameter of the tree canopy. Grade depressions resulting from root ball removal should be cleaned of loose material and backfilled in accordance with the recommendations in the “Compaction” section of this report.

6.1.3 Demolition of Existing Slabs, Foundations and Pavements

All slabs, foundations, and pavements should be completely removed from within planned building areas. A discussion of recycling existing improvements is provided later in this report.

6.1.4 Abandonment of Existing Utilities

All utilities should be completely removed from within planned building areas. For any utility line to be considered acceptable to remain within building areas, the utility line must not be in conflict with any new below grade structural element/improvement, be completely backfilled with grout or sand-cement slurry (sand slurry is not acceptable), the ends outside the building area capped with concrete, and the trench fills either removed and replaced as engineered fill with the trench side slopes flattened to at least 1:1, or the trench fills are determined not to be a risk to the structure. The assessment of the level of risk posed by the particular utility line will determine whether the utility may be abandoned in place or needs to be completely removed. The contractor should assume that all utilities will be removed from within building areas unless provided written confirmation from both the owner and the geotechnical engineer.

Utilities extending beyond the building area may be abandoned in place provided the ends are plugged with concrete, they do not conflict with planned improvements, and that the trench fills do not pose significant risk to the planned surface improvements.

6.2 REMOVAL OF EXISTING FILLS

Any fills encountered during site grading should be over-excavated and re-compacted from within at-grade building areas and to a lateral distance of at least 5 feet beyond the building footprint. Provided the fills meet the “Material for Fill” requirements below, the fills may be reused when backfilling the excavations. Based on review of the samples collected from our borings, it appears that the fill may be reused. If materials are encountered that do not meet the requirements, such as debris, wood, trash, those materials should be screened out of the remaining material and be removed from the site. Backfill of excavations should be placed in lifts and compacted in accordance with the “Compaction” section below.

Fills extending into planned pavement and flatwork areas may be left in place provided they are determined to be a low risk for future differential settlement and that the upper 12 to 18 inches of fill below pavement subgrade is re-worked and compacted as discussed in the “Compaction” section below.

6.3 TEMPORARY CUT AND FILL SLOPES

The contractor is responsible for maintaining all temporary slopes and providing temporary shoring where required. Temporary shoring, bracing, and cuts/fills should be performed in accordance with the strictest government safety standards. On a preliminary basis, the upper 15 feet at the site may be classified as OSHA Site C materials. Recommended soil parameters for temporary shoring are provided in the "Temporary Shoring" section of this report.

Excavations performed during site demolition and fill removal should be sloped at 3:1 (horizontal:vertical) within the upper 5 feet below building subgrade. Excavations extending more than 5 feet below building subgrade and excavations in pavement and flatwork areas should be slope at a 1:1 inclination unless the OSHA soil classification indicates that slope should not exceed 1.5:1.

6.4 BELOW-GRADE EXCAVATIONS

Below-grade excavations may be constructed with temporary slopes in accordance with the "Temporary Cut and Fill Slopes" section above if space allows. The choice of shoring method should be left to the contractor's judgment based on experience, economic considerations and adjacent improvements such as utilities, pavements, and foundation loads. Temporary shoring should support adjacent improvements without distress and should be the contractor's responsibility. A pre-condition survey including photographs and installation of monitoring points for existing site improvements should be included in the contractor's scope. We should be provided the opportunity to review the geotechnical parameters of the shoring design prior to implementation; the project structural engineer should be consulted regarding support of adjacent structures.

6.4.1 Temporary Shoring

Based on the site conditions encountered during our investigation, the cuts may be supported by soldier beams and tie-backs, braced excavations, or potentially other methods. Where shoring will extend more than about 10 feet, restrained shoring will most likely be required to limit detrimental lateral deflections and settlement behind the shoring. In addition to soil earth pressures, the shoring system will need to support adjacent loads such as construction vehicles and incidental loading, existing structure foundation loads, and street loading. We recommend that heavy construction loads (cranes, etc.) and material stockpiles be kept at least 15 feet behind the shoring. Where this loading cannot be set back, the shoring will need to be designed to support the loading. The shoring designer should provide for timely and uniform mobilization of soil pressures that will not result in excessive lateral deflections. Minimum suggested geotechnical parameters for shoring design are provided in the table below.

Table 2: Suggested Temporary Shoring Design Parameters

Design Parameter	Design Value
Minimum Lateral Wall Surcharge (upper 5 feet)	120 psf
Cantilever Wall – Triangular Earth Pressure	40 pcf
Restrained Wall – Trapezoidal Earth Pressure for clays	Increase from 0 to 25H* psf
Passive Pressure – Starting at 2 feet below the bottom of the excavation	400 pcf up to 2,000 psf maximum uniform pressure

* H equals the height of the excavation; passive pressures are assumed to act over twice the soldier pile diameter

The restrained earth pressure may also be distributed as described in Figure 24 of the *FHWA Circular No. 4 – Ground Anchors and Anchored Systems* (with the hinge points at ¼H and ¾H) provided the total pressure is established from the uniform pressure above.

If shotcrete lagging is used for the shoring facing, the permanent retaining wall drainage materials, as discussed in the “Wall Drainage” section of this report, will need to be installed during temporary shoring construction. At a minimum, 2-foot-wide vertical panels should be placed between soil nails or tiebacks that are spaced at 6-foot centers. For 8-foot centers, 4-foot-wide vertical panels should be provided. A horizontal strip drain connecting the vertical panels should be provided, or pass-through connections should be included for each vertical panel.

We performed our borings with rotary-wash drilling equipment and as such were not able to evaluate the potential for caving soils, which can create difficult conditions during soldier beam or tie-back installation; caving soils can also be problematic during excavation and lagging placement. The contractor is responsible for evaluating excavation difficulties prior to construction. Where relatively clean sands (especially encountered below ground water) or difficult drilling conditions were encountered during our exploration, pilot holes performed by the contractor may be desired to further evaluate these conditions prior to the finalization of the shoring budget.

In addition to anticipated deflection of the shoring system, other factors such as voids created by soil sloughing, and erosion of granular layers due to perched water conditions can create adverse ground subsidence and deflections. The contractor should attempt to cut the excavation as close to neat lines as possible; where voids are created, they should be backfilled as soon as possible with sand, gravel, or grout.

As previously mentioned, we recommend that a monitoring program be developed and implemented to evaluate the effects of the shoring on adjacent improvements. All sensitive improvements should be located and monitored for horizontal and vertical deflections and distress cracking based on a pre-construction survey. For multi-level excavations, the installation of inclinometers at critical areas may be desired for more detailed deflection monitoring. The monitoring frequency should be established and agree to by the project team prior to start of shoring construction.

The above recommendations are for the use of the design team; the contractor in conjunction with input from the shoring designer should perform additional subsurface exploration they deem necessary to design the chosen shoring system. A California-licensed civil or structural engineer must design and be in responsible charge of the temporary shoring design. The contractor is responsible for means and methods of construction, as well as site safety.

6.4.2 Underpinning

Where foundations for adjacent buildings are above an imaginary 1:1 line drawn up from the bottom of the proposed basement excavation, they should be underpinned, or the shoring should be designed to provide vertical and lateral support for adjacent structures. If underpinning is required, we judge slant piles or offset augercast piles will be acceptable methods to underpin adjacent structures. On a preliminary basis, underpinning piles/piers may be designed using an ultimate frictional resistance of 800 pounds per square foot, provided they are embedded at least 15 feet below the basement excavation level. The underpinning designer should apply an appropriate factor of safety to the above ultimate capacity, as required. To reduce movement and provide adequate foundation support during installation of the underpinning piers, adjacent piers should not be drilled or excavated concurrently. We recommend underpinning piers should be preloaded prior to dry packing. We should observe the installation of the underpinning piers to check that adequate embedment has been achieved.

If slant piles are used, they should be designed by the underpinning contractor, and we should review the geotechnical aspects of the underpinning design.

6.4.3 Construction Dewatering

Groundwater levels are expected to be about 5 to 10 feet *above* the planned excavation bottom; therefore, temporary dewatering will be necessary during construction. Design, selection of the equipment and dewatering method, and construction of temporary dewatering should be the responsibility of the contractor. Modifications to the dewatering system are often required in layered alluvial soils and should be anticipated by the contractor, especially for dewatering wells near EB-1/CPT-1. The dewatering plan, including planned dewatering well filter pack materials, should be forwarded to our office for review prior to implementation.

The dewatering design should maintain ground water at least 3 to 5 feet below the bottom of the mass excavation, and at least 2 feet below localized excavations such as deepened stacker pits, elevator shafts, and utilities. If the dewatering system was to shut down for an extended period of time, destabilization and/or heave of the excavation bottom requiring over-excavation and stabilization, flooding and softening, and/or shoring failures could occur; therefore, we recommend that a backup power source be considered.

Temporary draw down of the ground water table can cause the subsidence outside the excavation area, causing settlement of adjacent improvements. As a draw-down of 15 feet is likely required, we evaluated the potential deflection of existing adjacent areas. Our preliminary estimates indicate that there could be up to ½ to ¾ inch of settlement around of the site. If this settlement is deemed excessive, we recommend the alternative shoring methods SPTC or soil-cement walls be considered.

Depending on the ground water quality and previous environmental impacts to the site and surrounding area, settlement and storage tanks, particulate filtration, and environmental testing may be required prior to discharge, either into storm or sanitary, or trucked to an off-site facility.

6.5 AT-GRADE SUBGRADE PREPARATION

After site clearing and demolition is complete, and prior to backfilling any excavations resulting from fill removal or demolition, the at-grade excavation subgrade and subgrade within areas around the perimeter of the basement to receive additional site fills, slabs-on-grade and/or pavements should be scarified to a depth of 6 inches, moisture conditioned, and compacted in accordance with the “Compaction” section below.

6.6 SUBGRADE STABILIZATION MEASURES

Soil subgrade and fill materials, especially soils with high fines contents such as clays and silty soils, can become unstable due to high moisture content, whether from high in-situ moisture contents or from winter rains. As the moisture content increases over the laboratory optimum, it becomes more likely the materials will be subject to softening and yielding (pumping) from construction loading or become unworkable during placement and compaction.

There are several methods to address potential unstable soil conditions and facilitate fill placement and trench backfill. Some of the methods are briefly discussed below. Implementation of the appropriate stabilization measures should be evaluated on a case-by-case basis according to the project construction goals and the particular site conditions.

6.6.1 Scarification and Drying

The subgrade may be scarified to a depth of 6 to 13 inches and allowed to dry to near optimum conditions, if sufficient dry weather is anticipated to allow sufficient drying. More than one round of scarification may be needed to break up the soil clods.

6.6.2 Removal and Replacement

As an alternative to scarification, the contractor may choose to over-excavate the unstable soils and replace them with dry on-site or import materials. A Cornerstone representative should be present to provide recommendations regarding the appropriate depth of over-excavation, whether a geosynthethic (stabilization fabric or geogrid) is recommended, and what materials are recommended for backfill.

6.6.3 Chemical Treatment

Where the unstable area exceeds about 5,000 to 10,000 square feet and/or site winterization is desired, chemical treatment with quicklime (CaO), kiln-dust, or cement may be more cost-effective than removal and replacement. Recommended chemical treatment depths will typically range from 12 to 18 inches depending on the magnitude of the instability.

6.6.4 Below-Grade Excavation Stabilization

The proposed building excavation will extend into saturated silt, clay and sand with varying strength. Due to the high moisture content of these materials, it will likely become unstable under the weight of track-mounted or rubber-tired construction equipment. To provide a firm base for construction of the foundation, it may be necessary to remove approximately 12 to 18 inches of native soil below the foundation level and replace it with a bridging layer, such as crushed rock and a layer of stabilization fabric, such as Mirafi HP 370A or approved equivalent. The crushed rock should be consolidated in place with light vibratory equipment. Rubber-tire equipment should not be allowed to operate on the exposed subgrade; the crushed rock should be stockpiled and pushed out over the stabilization fabric. Lime and/or cement treatment can also be considered for the upper 12 to 18 inches of exposed basement soils, which would likely require 4 to 5 percent lime or cement to create a bridging layer. Lastly, a layer of lean cement-sand slurry layer (“rat slab”) may be considered or a combination of the two. Temporary dewatering to a depth of at least 3 to 5 feet below the bottom of the building excavation is recommended during construction.

6.7 MATERIAL FOR FILL

6.7.1 Re-Use of On-site Soils

On-site soils with an organic content less than 3 percent by weight may be reused as general fill. General fill should not have lumps, clods or cobble pieces larger than 6 inches in diameter; 85 percent of the fill should be smaller than 2½ inches in diameter. Minor amounts of oversize material (smaller than 12 inches in diameter) may be allowed provided the oversized pieces are not allowed to nest together and the compaction method will allow for loosely placed lifts not exceeding 12 inches.

6.7.2 Re-Use of On-Site Site Improvements

We anticipate that asphalt concrete (AC) grindings and aggregate base (AB) will be generated during site demolition. If the AC grindings are mixed with the underlying AB to meet Class 2 AB specifications, they may be reused within the new pavement and flatwork structural sections. AC/AB grindings may not be reused beneath the habitable areas. Laboratory testing will be required to confirm the grindings meet project specifications.

6.7.3 Potential Import Sources

Imported and non-expansive material should be inorganic with a Plasticity Index (PI) of 15 or less, and not contain recycled asphalt concrete where it will be used within the building areas. To prevent significant caving during trenching or foundation construction, imported material should have sufficient fines. Samples of potential import sources should be delivered to our office at least 10 days prior to the desired import start date. Information regarding the import source should be provided, such as any site geotechnical reports. If the material will be derived from an excavation rather than a stockpile, potholes will likely be required to collect samples from throughout the depth of the planned cut that will be imported. At a minimum, laboratory testing will include PI tests. Material data sheets for select fill materials (Class 2 aggregate base, ¾-inch crushed rock, quarry fines, etc.) listing current laboratory testing data (not older than 6 months from the import date) may be provided for our review without providing a sample. If current data is not available, specification testing will need to be completed prior to approval.

Environmental and soil corrosion characterization should also be considered by the project team prior to acceptance. Suitable environmental laboratory data to the planned import quantity should be provided to the project environmental consultant; additional laboratory testing may be required based on the project environmental consultant's review. The potential import source should also not be more corrosive than the on-site soils, based on pH, saturated resistivity, and soluble sulfate and chloride testing.

6.8 COMPACTION REQUIREMENTS

All fills, and subgrade areas where fill, slabs-on-grade, and pavements are planned, should be placed in loose lifts 8 inches thick or less and compacted in accordance with ASTM D1557 (latest version) requirements as shown in the table below. In general, clayey soils should be compacted with sheepsfoot equipment and sandy/gravelly soils with vibratory equipment; open-graded materials such as crushed rock should be placed in lifts no thicker than 18 inches consolidated in place with vibratory equipment. Each lift of fill and all subgrade should be firm and unyielding under construction equipment loading in addition to meeting the compaction requirements to be approved. The contractor (with input from a Cornerstone representative) should evaluate the in-situ moisture conditions, as the use of vibratory equipment on soils with high moistures can cause unstable conditions. General recommendations for soil stabilization are provided in the "Subgrade Stabilization Measures" section of this report. Where the soil's PI is 20 or greater, the expansive soil criteria should be used.

Table 3: Compaction Requirements

Description	Material Description	Minimum Relative[1] Compaction (percent)	Moisture[2] Content (percent)
General Fill (within upper 5 feet)	On-Site Soils	90	>1
General Fill (below a depth of 5 feet)	On-Site Soils	95	>1
Basement Wall Backfill	Without Surface Improvements	90	>1
Basement Wall Backfill	With Surface Improvements	95[4]	>1
Trench Backfill	On-Site Soils	90	>1
Trench Backfill (upper 6 inches of subgrade)	On-Site Soils	95	>1
Crushed Rock Fill	¾-inch Clean Crushed Rock	Consolidate In-Place	NA
Non-Expansive Fill	Imported Non-Expansive Fill	90	Optimum
Flatwork Subgrade	On-Site Soils	90	>1
Flatwork Aggregate Base	Class 2 Aggregate Base[3]	90	Optimum
Pavement Subgrade	On-Site Soils	95	>1
Pavement Aggregate Base	Class 2 Aggregate Base[3]	95	Optimum
Asphalt Concrete	Asphalt Concrete	95	NA

1 – Relative compaction based on maximum density determined by ASTM D1557 (latest version)
2 – Moisture content based on optimum moisture content determined by ASTM D1557 (latest version)
3 – Class 2 aggregate base shall conform to Caltrans Standard Specifications, latest edition, except that the relative compaction should be determined by ASTM D1557 (latest version)
4 – Using light-weight compaction or walls should be braced

6.9 TRENCH BACKFILL

Utility lines constructed within public right-of-way should be trenched, bedded and shaded, and backfilled in accordance with the local or governing jurisdictional requirements. Utility lines in private improvement areas should be constructed in accordance with the following requirements unless superseded by other governing requirements.

All utility lines should be bedded and shaded to at least 6 inches over the top of the lines with crushed rock (⅜-inch-diameter or greater) or well-graded sand and gravel materials conforming to the pipe manufacturer's requirements. Open-graded shading materials should be consolidated in place with vibratory equipment and well-graded materials should be compacted to at least 90 percent relative compaction with vibratory equipment prior to placing subsequent backfill materials.

General backfill over shading materials may consist of on-site native materials provided they meet the requirements in the “Material for Fill” section, and are moisture conditioned and compacted in accordance with the requirements in the “Compaction” section.

Where utility lines will cross perpendicular to strip footings, the footing should be deepened to encase the utility line, providing sleeves or flexible cushions to protect the pipes from anticipated foundation settlement, or the utility lines should be backfilled to the bottom of footing with sand-cement slurry or lean concrete. Where utility lines will parallel footings and will extend below the “foundation plane of influence,” an imaginary 1:1 plane projected down from the bottom edge of the footing, either the footing will need to be deepened so that the pipe is above the foundation plane of influence or the utility trench will need to be backfilled with sand-cement slurry or lean concrete within the influence zone. Sand-cement slurry used within foundation influence zones should have a minimum compressive strength of 75 psi.

6.10 SITE DRAINAGE

Ponding should not be allowed adjacent to building foundations, slabs-on-grade, or pavements. Hardscape surfaces should slope at least 2 percent towards suitable discharge facilities; landscape areas should slope at least 3 percent to at least 10 feet from the structure. Roof runoff should be directed away from building areas in closed conduits, to approved infiltration facilities, or on to hardscaped surfaces that drain to suitable facilities. Retention, detention or infiltration facilities should be spaced at least 10 feet from buildings, and preferably at least 5 feet from slabs-on-grade or pavements.

6.11 LOW-IMPACT DEVELOPMENT (LID) IMPROVEMENTS

The Municipal Regional Permit (MRP) requires regulated projects to treat 100 percent of the amount of runoff identified in Provision C.3.d from a regulated project’s drainage area with low impact development (LID) treatment measures onsite or at a joint stormwater treatment facility. LID treatment measures are defined as rainwater harvesting and use, infiltration, evapotranspiration, or biotreatment. A biotreatment system may only be used if it is infeasible to implement harvesting and use, infiltration, or evapotranspiration at a project site.

Technical infeasibility of infiltration may result from site conditions that restrict the operability of infiltration measures and devices. Various factors affecting the feasibility of infiltration treatment may create an environmental risk, structural stability risk, or physically restrict infiltration. The presence of any of these limiting factors may render infiltration technically infeasible for a proposed project. To aid in determining if infiltration may be feasible at the site, we provide the following site information regarding factors that may aid in determining the feasibility of infiltration facilities at the site.

- Seasonal high groundwater is not mapped in the area, but a design groundwater level of 5 feet below grade is recommended for the site. Therefore, groundwater is expected to seasonally be within 10 feet below the base of the infiltration measure.

- In our opinion, infiltration locations within 10 feet of the buildings would create a geotechnical hazard.

6.11.1 Storm Water Treatment Design Considerations

If storm water treatment improvements, such as shallow bio-retention swales, basins or pervious pavements, are required as part of the site improvements to satisfy Storm Water Quality (C.3) requirements, we recommend the following items be considered for design and construction.

6.11.1.1 General Bioswale Design Guidelines

- If possible, avoid placing bioswales or basins within 10 feet of the building perimeter or within 5 feet of exterior flatwork or pavements. If bioswales must be constructed within these setbacks, the side(s) and bottom of the trench excavation should be lined with minimum 15-mil visqueen to reduce water infiltration into the surrounding soil.

- Bioswales constructed within 3 feet of proposed buildings may be within the foundation zone of influence for perimeter wall loads. Therefore, where bioswales will parallel foundations and will extend below the “foundation plane of influence,” an imaginary 1:1 plane projected down from the bottom edge of the foundation, the foundation will need to be deepened so that the bottom edge of the bioswale filter material is above the foundation plane of influence.

- The bottom of bioswale or detention areas should include a perforated drain placed at a low point, such as a shallow trench or sloped bottom, to reduce water infiltration into the surrounding soils near structural improvements.

6.11.1.2 Bioswale Infiltration Material

- Gradation specifications for bioswale filter material, if required, should be specified on the grading and improvement plans.

- Compaction requirements for bioswale filter material in non-landscaped areas or in pervious pavement areas, if any, should be indicated on the plans and specifications to satisfy the anticipated use of the infiltration area.

- If bioswales are to be vegetated, the landscape architect should select planting materials that do not reduce or inhibit the water infiltration rate, such as covering the bioswale with grass sod containing a clayey soil base.

- If required by governing agencies, field infiltration testing should be specified on the grading and improvement plans. The appropriate infiltration test method, duration and frequency of testing should be specified in accordance with local requirements.

- Due to the relatively loose consistency and/or high organic content of many bioswale filter materials, long-term settlement of the bioswale medium should be anticipated. To reduce initial volume loss, bioswale filter material should be wetted in 12-inch lifts during placement to pre-consolidate the material. Mechanical compaction should not be allowed, unless specified on the grading and improvement plans, since this could significantly decrease the infiltration rate of the bioswale materials.

- It should be noted that the volume of bioswale filter material may decrease over time depending on the organic content of the material. Additional filter material may need to be added to bioswales after the initial exposure to winter rains and periodically over the life of the bioswale areas, as needed.

6.11.1.3 Bioswale Construction Adjacent to Pavements

If bio-infiltration swales or basins are considered adjacent to proposed parking lots or exterior flatwork, we recommend that mitigative measures be considered in the design and construction of these facilities to reduce potential impacts to flatwork or pavements. Exterior flatwork, concrete curbs, and pavements located directly adjacent to bio-swales may be susceptible to settlement or lateral movement, depending on the configuration of the bioswale and the setback between the improvements and edge of the swale. To reduce the potential for distress to these improvements due to vertical or lateral movement, the following options should be considered by the project civil engineer:

- Improvements should be setback from the vertical edge of a bioswale such that there is at least 1 foot of horizontal distance between the edge of improvements and the top edge of the bioswale excavation for every 1 foot of vertical bioswale depth, or

- Concrete curbs for pavements, or lateral restraint for exterior flatwork, located directly adjacent to a vertical bioswale cut should be designed to resist lateral earth pressures in accordance with the recommendations in the “Retaining Walls” section of this report, or concrete curbs or edge restraint should be adequately keyed into the native soil or engineered to reduce the potential for rotation or lateral movement of the curbs.

SECTION 7: 2019 CBC SEISMIC DESIGN CRITERIA

We developed site-specific seismic design parameters in accordance with Chapter 16, Chapter 18 and Appendix J of the 2019 California Building Code (CBC) and Chapters 11, 12, 20, and 21 and Supplement No. 1 of ASCE 7-16.

7.1 SITE LOCATION AND PROVIDED DATA FOR 2019 CBC SEISMIC DESIGN

The project is located at latitude 36.966191° and longitude -122.026252°, which is based on Google Earth (WGS84) coordinates at the approximate center of the site at 130 Center Street in Santa Cruz, California. We have assumed that a Seismic Importance Factor (I_e) of 1.00 has been assigned to the structure in accordance with Table 1.5-2 of ASCE 7-16 for structures classified as Risk Category II. The building period has not been provided by the project structural engineer.

7.2 SITE CLASSIFICATION – CHAPTER 20 OF ASCE 7-16

Code-based site classification and ground motion attenuation relationships are based on the time-weighted average shear wave velocity of the top approximately 100 feet (30 meters) of the soil profile (V_{S30}).

As discussed in Section 3, our explorations generally encountered stiff to soft lean clays and silts and loose to dense sands deposits to a depth of 100 feet, the maximum depth explored. Shear wave velocity (V_S) measurements were performed while advancing on all the CPT's on site, but only CPT-5 was advanced to a depth of 100 feet, resulting in a time-averaged shear wave velocity for the top 30 meters (V_{S30}) of approximately 608 feet per second. In accordance with Table 20.3-1 of ASCE 7-16, we recommend the site be classified as Soil Classification D, which is described as a "stiff soil" profile. Because we used site specific data from our explorations and laboratory testing, the site class should be considered as "determined" for the purposes of estimating the seismic design parameters from the code outlined below. Site Response Analysis considered a V_{S30} of 608 ft/s (185 m/s).

7.2.1 Code-Based Seismic Design Parameters

Code-based spectral acceleration parameters were determined based on mapped acceleration response parameters adjusted for the specific site conditions. Mapped Risk-Adjusted Maximum Considered Earthquake (MCE_R) spectral acceleration parameters (S_S and S_1) were determined using the ATC Hazards by Location website (https://hazards.atcouncil.org).

The mapped acceleration parameters were adjusted for local site conditions based on the average soil conditions for the upper 100 feet (30 meters) of the soil profile. Code-based MCE_R spectral response acceleration parameters adjusted for site effects (S_{MS} and S_{M1}) and design spectral response acceleration parameters (S_{DS} and S_{D1}) are presented in Table 4.

In accordance with Section 11.4.8 of ASCE 7-16, structures on Site Class D sites with mapped 1-second period spectral acceleration (S_1) values greater than or equal to 0.2 require a Site Response Analysis be performed in accordance with Section 21.1 of ASCE 7-16. ***Design seismic parameters determined by performing a Site Response Analysis per Section 21.1 of ASCE 7-16 are presented in Table 4. Recommended values in Table 4 should not be used for design.*** Values summarized in Table 4 are only used to determine Seismic Design Category and comparison with minimum code requirements for further use in our Site Response Analysis (SRA).

Table 4: 2019 CBC Site Categorization and Site Coefficients

Classification/Coefficient	Design Value
Site Class	D
Site Latitude	36.966191°
Site Longitude	-122.026252°
Risk Category	II
Short Period Mapped Spectral Acceleration – S_S	1.628 g
1-second Period Mapped Spectral Acceleration – S_1	0.621 g
Short-Period Site Coefficient – F_a	1.0
Long-Period Site Coefficient – F_v	*null
Short Period MCE Spectral Response Acceleration Adjusted for Site Effects – S_{MS}	1.628 g
1-second Period MCE Spectral Response Acceleration Adjusted for Site Effects – S_{M1}	*null
Short Period, Design Earthquake Spectral Response Acceleration – S_{DS}	1.085 g
1-second Period, Design Earthquake Spectral Response Acceleration – S_{D1}	*null
Long-Period Transition – T_L	12 seconds
Site Coefficient – F_{PGA}	1.1
Site Modified Peak Ground Acceleration – PGA_M	0.752 g

*null – per section 11.4.8 of ASCE 7-16

7.3 SITE RESPONSE ANALYSIS

Following Section 11.4.8 of ASCE 7-16, our technical partner, Robert Pyke, PhD., G.E., performed a Site Response Analysis (SRA) in accordance with Chapter 21, Section 21.1. The details of the SRA are presented in Appendix D. The recommended MCE Spectrum is shown graphically on Figure 13 and tabulated in Table 2 of Appendix D.

The recommended seismic design parameters are summarized in Table 5.

When using the Equivalent Lateral Force Procedure, ASCE 7-16 Section 21.4 allows using the spectral acceleration at any period (T) in lieu of S_{D1}/T in Eq. 12.8-3 and $S_{D1}T_L/T_2$ in Eq. 12.8-4. The site-specific spectral acceleration at any period may be calculated by interpolation of the spectral ordinates in Table 2, Appendix D. We note that the recommended MCE spectrum apply to structures founded at the ground surface. They will likely be conservative for the design of the below-grade mat supported structure. Analysis for the building allows for a reduction to as low as 70 percent of the standard code spectrum in accordance with Section 19.2.3(4) of ASCE 7-16.

Table 5: Site-Specific Design Acceleration Parameters

Parameter	Value
S_{DS}	0.76 g
S_{D1}	0.73 g
S_{MS}	1.14 g
S_{M1}	1.09 g

SECTION 8: FOUNDATIONS

8.1 SUMMARY OF RECOMMENDATIONS

In our opinion, the proposed structure may be supported on a rigid mat foundation provided the recommendations in the “Earthwork” section and the sections below are followed.

8.2 SHALLOW FOUNDATIONS

8.2.1 Reinforced Concrete Mat Foundation

As discussed, the basement will be constructed one level below existing grades. Therefore, the estimated bottom of foundation will be at depths of approximately 15 feet below grade. Based on the estimated depth of the parking levels and the design groundwater level, and the potential for liquefaction-induced settlement, we recommend that the proposed structure be supported on a mat foundation provided the following constraints can be addressed during design.

We recommend that the average allowable bearing pressure of 2,500 psf be used for the mat area. The maximum bearing pressure may be increased by one-third for all loads, including wind or seismic. Top and bottom reinforcing steel should be included as required to help span irregularities and differential settlement. It is essential that we observe the mat foundation pad prior to placement of reinforcing steel.

8.2.2 Mat Foundation Settlement

Based on the preliminary foundation contact pressure of 1,800 psf and our settlement analysis, we estimate total static settlements of ½ to ¾-inch across the mat area for a reinforced concrete. We anticipate that approximately 25 to 30 percent of the settlement would occur during construction, therefore, approximately ¼ inch of differential settlement is anticipated between adjacent foundation elements.

Our analysis indicates that liquefaction-induced settlement on the order of approximately 2 to 2½ inches could occur in the vicinity of Boring EB-1/CPT-1 near the northeast portion of the site, resulting in differential settlement up to 1 to 1½ inches. Liquefaction induced settlement across the remainder of the site is estimated to be less than 1 inch.

Combined static and seismic differential settlement between adjacent foundation elements, assumed to be spaced approximately 30 feet apart, is estimated to be approximately 1 to 1¾ inches. If this magnitude of differential settlement is not considered feasible, ground improvement can be considered below all or portions of the mat, as discussed in the following sections.

8.2.3 Mat Foundation Lateral Loading

Lateral loads may be resisted by friction between the bottom of mat foundation and the supporting subgrade, and also by passive pressures generated against deepened mat edges. An ultimate frictional resistance of 0.45 applied to the mat dead load, and an ultimate passive pressure based on an equivalent fluid pressure of 500 pcf may be used in design. The structural engineer should apply an appropriate factor of safety (such as 1.5) to the ultimate values above.

8.2.4 Mat Modulus of Subgrade Reaction

The modulus of soil subgrade reaction is a model element that represents the response to a specific loading condition, including the magnitude, rate, and shape of loading, given the subsurface conditions at that location. Design experts recommend using a variable modulus of soil subgrade reaction to provide a more accurate soil response and prediction of shears and moments in the mats. This will require at least one iteration between our soil model and the structural SAFE (or similar) analysis for the mat. As discussed above, the structural engineer provided a preliminary average areal mat pressure of 1,800 psf within the structure. Based on this pressure, we calculated a preliminary modulus of subgrade reaction value for the mat foundation.

For preliminary SAFE runs (or equivalent analysis), we recommend an initial modulus of soil subgrade reaction of 10 pounds per cubic inch (pci) for the mat foundation. As discussed above, the modulus of soil subgrade reaction is intended for use in the first iteration of the structural SAFE analysis for the mat design. Once the initial structural analysis is complete, please forward a color plot of contact pressures for the mat (to scale) so that we can provide a revised plan with updated contours of equal modulus of soil subgrade reaction values.

8.2.5 Mat Foundation Construction Considerations

Prior to placement of any water proofing and mat construction, the subgrade should be proof-rolled and visually observed by a Cornerstone representative to confirm stable subgrade conditions. The building pad should generally be kept free of water and disturbed materials prior to pouring the foundation.

8.2.6 Hydrostatic Uplift and Waterproofing

As discussed, groundwater was encountered at depths of 8 feet below the existing grades, and a design groundwater depth of 5 feet was estimated based on available groundwater data in the downtown Santa Cruz area. Where portions of the structures extend below the design groundwater level, including the bottom of mat foundation, they should be designed to resist potential hydrostatic uplift pressures. Retaining walls extending below design groundwater should be waterproofed and designed to resist hydrostatic pressure for the full wall height.

In addition, the portions of the structures extending below design groundwater should be waterproofed to limit moisture infiltration, including mat foundation areas, all construction joints, and any retaining walls. We recommend that a waterproof specialist design the waterproofing system.

8.3 GROUND IMPROVEMENT

As discussed above, if the estimated total and differential mat foundation settlement is not tolerable, the mat foundation supporting the building may be used in combination with ground improvement. If considered, we recommend that ground improvement be performed in the upper 30 feet in the general vicinity of Boring EB-1/CPT-1 (northeast portion of the building footprint) to mitigate liquefaction settlement. Ground improvement can be used to improve the subsurface soils such that the total combined static and seismic settlements are reduced to less than 1½ inches with ½ to ¾ inches differential settlement over a horizontal distance of 30 feet, enabling the structure to be supported on a more efficient mat foundation. Ground improvement should provide adequate confining improvement around all foundations. Ground improvement options should also include an increase in allowable bearing pressures and should reduce settlement to within the tolerances stated above. Our analysis indicates that performing ground improvement below 30 to 40 feet may amplify the site response beneath the building to above code levels and is not needed.

8.3.1 Ground Improvement Requirements

Ground improvement should consist of densification techniques to improve the ground’s resistance to liquefaction, reduce static settlement, and improve bearing capacity and seismic performance. Densification techniques could potentially consist of vibro-replacement (i.e. stone columns), grouted displacement columns (i.e. CLSM), or similar densification techniques. The intent of the ground improvement design beneath the proposed building would be to increase the density of the potentially liquefiable silts and sands within upper 30 to 35 feet below existing grade by laterally displacing and/or densifying the existing in-place soils.

Based on the conditions encountered during our explorations, drilled displacement columns, stone columns, or a combination of both, appear to be feasible ground improvement options for this project. The surrounding soils are densified by the displacement of the soil as well as the vibrations from consolidating and expanding the gravel column laterally. One of the disadvantages of these densification pile types are the noise and vibration (and sometimes dust) produced during construction. The vibrations may cause noise and vibrations that can be heard or felt off-site. To limit vibrations on the adjacent properties it may be desired to perform drilled displacement or CLSM columns around the perimeter.

Drilled displacement columns are formed in displaced soil cavities and displace liquefiable and compressible soil with cemented Controlled Low Strength Material. CLSM column ground improvement can mitigate liquefaction and settlement of heavy foundations and slabs. CLSM columns are ideal for sensitive project sites such as those near critical structures that require low noise and no vibration construction methods, unreinforced masonry walls, occupied offices, sensitive soil (e.g. Bay Mud), and hazardous/contaminated soil sites where deep ground improvement is required.

Based on the chosen ground improvement technique, the upper 3 feet or more of the working pad will likely need to be re-compacted after ground improvement installation, due to surface disturbance, and potential ground heave. For this reason, we do not recommend preparation of the building pad or the construction of utilities prior to ground improvement.

The diameter of these ground improvement elements would be 24 to 30 inches and spacing would be proposed by the ground improvement contractors based on their experience and documented case histories of improvement performed on other projects with similar soil conditions which we would review as part of their submittal. The spacing would be estimated to improve the sands to obtain a post treatment $(N_1)_{60cs}$ of at least 25 blows/foot. The spacing would also be selected to reduce the total seismic settlement to 1½ inches with a differential settlement of ¾ inches over a horizontal distance of 30 feet. We would anticipate spacing on the order of 6 to 8 feet but may consider alternate spacing with well documented case history backup from the ground improvement contractor. We would propose to use a method specification for the installation of the ground improvement elements and forgo any pre-production test areas or post production verification testing provided that ground improvement contractors can demonstrate with well documented case histories that their proposed spacing has produced an $(N_1)_{60cs}$ of 25 blows per foot in the sand layers described above. We would recommend a modulus test at the on-set of construction to verify that the ground improvement will control the static settlement. This recommendation is predicated on our working with and reviewing the ground improvement contactors submittal documentation on their proposed spacing and installation methodology and case histories from other similar projects. We would also independently observe installation in the field and prepare a signed and stamped close-out letter with confirms that installed ground improvement meets our recommendations.

8.3.2 Ground Improvement Design Guidelines

We recommend that the ground improvement design include, but not be limited to: 1) drawings showing the ground improvement layout, spacing and diameter, 2) the foundation layout plan, 3) proposed ground improvement length, 4) top and bottom elevations, 5) case histories showing pre and post improvement $(N_1)_{60cs}$ or Q_{C1cs} values for projects with similar site conditions, 6) estimate of static settlement and modulus to meet settlement goals. We should be retained to review the ground improvement contractor's plan and densification estimates prior to construction, and to review and confirm that the contractor's ground improvement design will satisfactorily meet the design criteria based on the previous performance testing. Ground improvement would generally be constructed as follows: 1) clear the site of existing demolition debris, 2) mass grading to the building pad subgrade elevation, 3) install the ground improvement on the approved layout, and 4) over-excavation and re-compact top of building pad, as required, prior to construction of remainder of pad and the foundations.

The degree to which the soil density is increased will depend on the improvement method and spacing. Even though the above methods are designed to mitigate different existing soil conditions, ground improvement should provide an additional increase in bearing capacity and soil stiffness at the individual improvement locations.

SECTION 9: CONCRETE SLABS AND PEDESTRIAN PAVEMENTS

9.1 INTERIOR SLABS-ON-GRADE

Any proposed at-grade, interior slabs-on-grade should be underlain by at least 6 inches of non-expansive fill supported directly on subgrade prepared in accordance with the recommendations in the “Earthwork” section of this report. If moisture-sensitive floor coverings are planned, the recommendations in the “Interior Slabs Moisture Protection Considerations” section below may be incorporated in the project design if desired. If significant time elapses between initial subgrade preparation and slab-on-grade construction, the subgrade should be proof-rolled to confirm subgrade stability, and if the soil has been allowed to dry out, the subgrade should be re-moisture conditioned to near optimum moisture content.

The structural engineer should determine the appropriate slab reinforcement for the loading requirements and considering the expansion potential of the underlying soils. Consideration should be given to limiting the control joint spacing to a maximum of about 2 feet in each direction for each inch of concrete thickness.

9.2 PEDESTRIAN CONCRETE FLATWORK

Exterior concrete flatwork subject to pedestrian and/or occasional light pick up loading should be at least 4 inches thick and supported on at least 4 inches of Class 2 aggregate base overlying subgrade prepared in accordance with the “Earthwork” recommendations of this report. Flatwork that will be subject to heavier or frequent vehicular loading should be designed in accordance with the recommendations in the “Vehicular Pavements” section below. To help reduce the potential for uncontrolled shrinkage cracking, adequate expansion and control joints should be included. Consideration should be given to limiting the control joint spacing to a maximum of about 2 feet in each direction for each inch of concrete thickness. Flatwork should be isolated from adjacent foundations or retaining walls except where limited sections of structural slabs are included to help span irregularities in retaining wall backfill at the transitions between at-grade and on-structure flatwork.

SECTION 10: VEHICULAR PAVEMENTS

10.1 ASPHALT CONCRETE

The following asphalt concrete pavement recommendations tabulated below are based on the Procedure 608 of the Caltrans Highway Design Manual, estimated traffic indices for various pavement-loading conditions, and on a design R-value of 5. The design R-value was chosen based on the results of the laboratory testing and engineering judgment considering the clayey surface conditions.

Table 6: Asphalt Concrete Pavement Recommendations, Design R-value = 5

Design Traffic Index (TI)	Asphalt Concrete (inches)	Class 2 Aggregate Base* (inches)	Total Pavement Section Thickness (inches)
4.0	2.5	7.5	10.0
4.5	2.5	9.5	12.0
5.0	3.0	10.0	13.0
5.5	3.0	12.0	15.0
6.0	3.5	12.5	16.0
6.5	4.0	14.0	18.0

*Caltrans Class 2 aggregate base; minimum R-value of 78

Frequently, the full asphalt concrete section is not constructed prior to construction traffic loading. This can result in significant loss of asphalt concrete layer life, rutting, or other pavement failures. To improve the pavement life and reduce the potential for pavement distress through construction, we recommend the full design asphalt concrete section be constructed prior to construction traffic loading. Alternatively, a higher traffic index may be chosen for the areas where construction traffic will \ use the pavements.

10.2 PORTLAND CEMENT CONCRETE

The exterior Portland Cement Concrete (PCC) pavement recommendations tabulated below are based on methods presented in the Portland Cement Association (PCA) design manual (PCA, 1984), and are intended for use for vehicular entry driveways, loading areas or emergency vehicle areas. We have provided two pavement alternatives as an anticipated Average Daily Truck Traffic (ADTT) was not provided. An allowable ADTT should be chosen that is greater than what is expected for the development.

Table 7: PCC Pavement Recommendations

Allowable ADTT	Minimum PCC Thickness (inches)
13	5½
130	6

The PCC thicknesses above are based on a concrete compressive strength of at least 3,500 psi, supporting the PCC on at least 6 inches of Class 2 aggregate base compacted as recommended in the "Earthwork" section, and laterally restraining the PCC with curbs or concrete shoulders. Adequate expansion and control joints should be included. Consideration should be given to limiting the control joint spacing to a maximum of about 2 feet in each direction for each inch of concrete thickness.

10.3 Stress Pads for Trash Enclosures

Pads where trash containers will be stored, and where garbage trucks will park while emptying trash containers, should be constructed on Portland Cement Concrete. We recommend that the trash enclosure pads and stress (landing) pads where garbage trucks will store, pick up, and empty trash be increased to a minimum PCC thickness of 7 inches. The compressive strength, underlayment, and construction details should be consistent with the above recommendations for PCC pavements.

SECTION 11: RETAINING WALLS

11.1 STATIC LATERAL EARTH PRESSURES

The structural design of any site retaining wall should include resistance to lateral earth pressures that develop from the soil behind the wall, any undrained water pressure, and surcharge loads acting behind the wall. Provided a drainage system is constructed behind the wall to prevent the build-up of hydrostatic pressures as discussed in the section below, we recommend that the walls with level backfill be designed for the following pressures:

Table 8: Recommended Lateral Earth Pressures

Wall Condition	Lateral Earth Pressure*	Additional Surcharge Loads
Unrestrained – Cantilever Wall	40 pcf	⅓ of vertical loads at top of wall
Restrained – Braced Wall	80 pcf + 8H** psf	½ of vertical loads at top of wall

* Lateral earth pressures are based on an equivalent fluid pressure for level backfill conditions
** H is the distance in feet between the bottom of footing and top of retained soil

Basement walls should be designed as restrained walls and are assumed to be designed as undrained walls. If adequate drainage cannot be provided behind at-grade walls, an additional equivalent fluid pressure of 40 pcf should be added to the values above for both restrained and unrestrained walls for the portion of the wall that will not have drainage. Damp proofing or waterproofing of the walls may be considered where moisture penetration and/or efflorescence are not desired.

11.2 SEISMIC LATERAL EARTH PRESSURES

The 2019 California Building Code (CBC) states that lateral pressures from earthquakes should be considered in the design of basements and retaining walls. We developed seismic earth pressures for the proposed basement using interim recommendations generally based on refinement of the Mononobe-Okabe method (Lew et al., SEAOC 2010). Because the walls are greater than 12 feet in height, and peak ground accelerations are greater than 0.40g, we checked the result of the seismic increment when added to the recommended active earth pressure against the recommended fixed wall earth pressures.

Because the wall is restrained, or will act as a restrained wall, and will be designed for 45 pcf (equivalent fluid pressure) plus a uniform earth pressure of 8H psf, based on current recommendations for seismic earth pressures, it appears that active earth pressures plus a seismic increment do not exceed the fixed wall earth pressures. Therefore, an additional seismic increment above the design earth pressures is not required as long as the walls are designed for the restrained wall earth pressures recommended above in accordance with the CBC

11.3 BACKFILL

Where surface improvements will be located over the retaining wall backfill, backfill placed behind the walls should be compacted to at least 95 percent relative compaction using light compaction equipment. Where no surface improvements are planned, backfill should be compacted to at least 90 percent. If heavy compaction equipment is used, the walls should be temporarily braced.

11.4 AT-GRADE WALL DRAINAGE

Adequate drainage should be provided by a subdrain system behind all walls. This system should consist of a 4-inch minimum diameter perforated pipe placed near the base of the wall (perforations placed downward). The pipe should be bedded and backfilled with Class 2 Permeable Material per Caltrans Standard Specifications, latest edition. The permeable backfill should extend at least 12 inches out from the wall and to within 2 feet of outside finished grade. Alternatively, ½-inch to ¾-inch crushed rock may be used in place of the Class 2 Permeable Material provided the crushed rock and pipe are enclosed in filter fabric, such as Mirafi 140N or approved equivalent. The upper 2 feet of wall backfill should consist of compacted on-site soil. The subdrain outlet should be connected to a free-draining outlet or sump.

Miradrain, Geotech Drainage Panels, or equivalent drainage matting can be used for wall drainage as an alternative to the Class 2 Permeable Material or drain rock backfill. Horizontal strip drains connecting to the vertical drainage matting may be used in lieu of the perforated pipe and crushed rock section. The vertical drainage panel should be connected to the perforated pipe or horizontal drainage strip at the base of the wall, or to some other closed or through-wall system such as the TotalDrain system from AmerDrain. Sections of horizontal drainage strips should be connected with either the manufacturer’s connector pieces or by pulling back the filter fabric, overlapping the panel dimples, and replacing the filter fabric over the connection. At corners, a corner guard, corner connection insert, or a section of crushed rock covered with filter fabric must be used to maintain the drainage path.

Drainage panels should terminate 18 to 24 inches from final exterior grade. The Miradrain panel filter fabric should be extended over the top of and behind the panel to protect it from intrusion of the adjacent soil.

11.5 BACKFILL

Where surface improvements will be located over the retaining wall backfill, backfill placed behind the walls should be compacted to at least 95 percent relative compaction using light compaction equipment. Where no surface improvements are planned, backfill should be compacted to at least 90 percent. If heavy compaction equipment is used, the walls should be temporarily braced.

As discussed previously, consideration should be given to the transitions from on-grade to on-structure. Providing sub-slabs or other methods for reducing differential movement of flatwork or pavements across this transition should be included in the project design.

11.5 FOUNDATIONS

Basement retaining walls may be supported on the basement level mat designed in accordance with the recommendations presented in the “Foundations” section of this report. If at-grade walls are planned, walls may be supported on conventional footings that are at least 18 inches wide, extend at least 18 inches below lowest adjacent grade, and are designed for allowable bearing pressures of 2,000, 3,000 and 4,000 psf for dead, dead plus live, and all loads, respectively.

SECTION 12: LIMITATIONS

This report, an instrument of professional service, has been prepared for the sole use of Swenson specifically to support the design of the Center Street Residential Development project in Santa Cruz, California. The opinions, conclusions, and recommendations presented in this report have been formulated in accordance with accepted geotechnical engineering practices that exist in Northern California at the time this report was prepared. No warranty, expressed or implied, is made or should be inferred.

Recommendations in this report are based upon the soil and ground water conditions encountered during our subsurface exploration. If variations or unsuitable conditions are encountered during construction, Cornerstone must be contacted to provide supplemental recommendations, as needed.

Swenson may have provided Cornerstone with plans, reports and other documents prepared by others. Swenson understands that Cornerstone reviewed and relied on the information presented in these documents and cannot be responsible for their accuracy.

Cornerstone prepared this report with the understanding that it is the responsibility of the owner or his representatives to see that the recommendations contained in this report are presented to other members of the design team and incorporated into the project plans and specifications, and that appropriate actions are taken to implement the geotechnical recommendations during construction.

Conclusions and recommendations presented in this report are valid as of the present time for the development as currently planned. Changes in the condition of the property or adjacent properties may occur with the passage of time, whether by natural processes or the acts of other persons. In addition, changes in applicable or appropriate standards may occur through legislation or the broadening of knowledge. Therefore, the conclusions and recommendations presented in this report may be invalidated, wholly or in part, by changes beyond Cornerstone's control. This report should be reviewed by Cornerstone after a period of three (3) years has elapsed from the date of this report. In addition, if the current project design is changed, then Cornerstone must review the proposed changes and provide supplemental recommendations, as needed.

An electronic transmission of this report may also have been issued. While Cornerstone has taken precautions to produce a complete and secure electronic transmission, please check the electronic transmission against the hard copy version for conformity.

Recommendations provided in this report are based on the assumption that Cornerstone will be retained to provide observation and testing services during construction to confirm that conditions are similar to that assumed for design, and to form an opinion as to whether the work has been performed in accordance with the project plans and specifications. If we are not retained for these services, Cornerstone cannot assume any responsibility for any potential claims that may arise during or after construction as a result of misuse or misinterpretation of Cornerstone's report by others. Furthermore, Cornerstone will cease to be the Geotechnical-Engineer-of-Record if we are not retained for these services.

SECTION 13: REFERENCES

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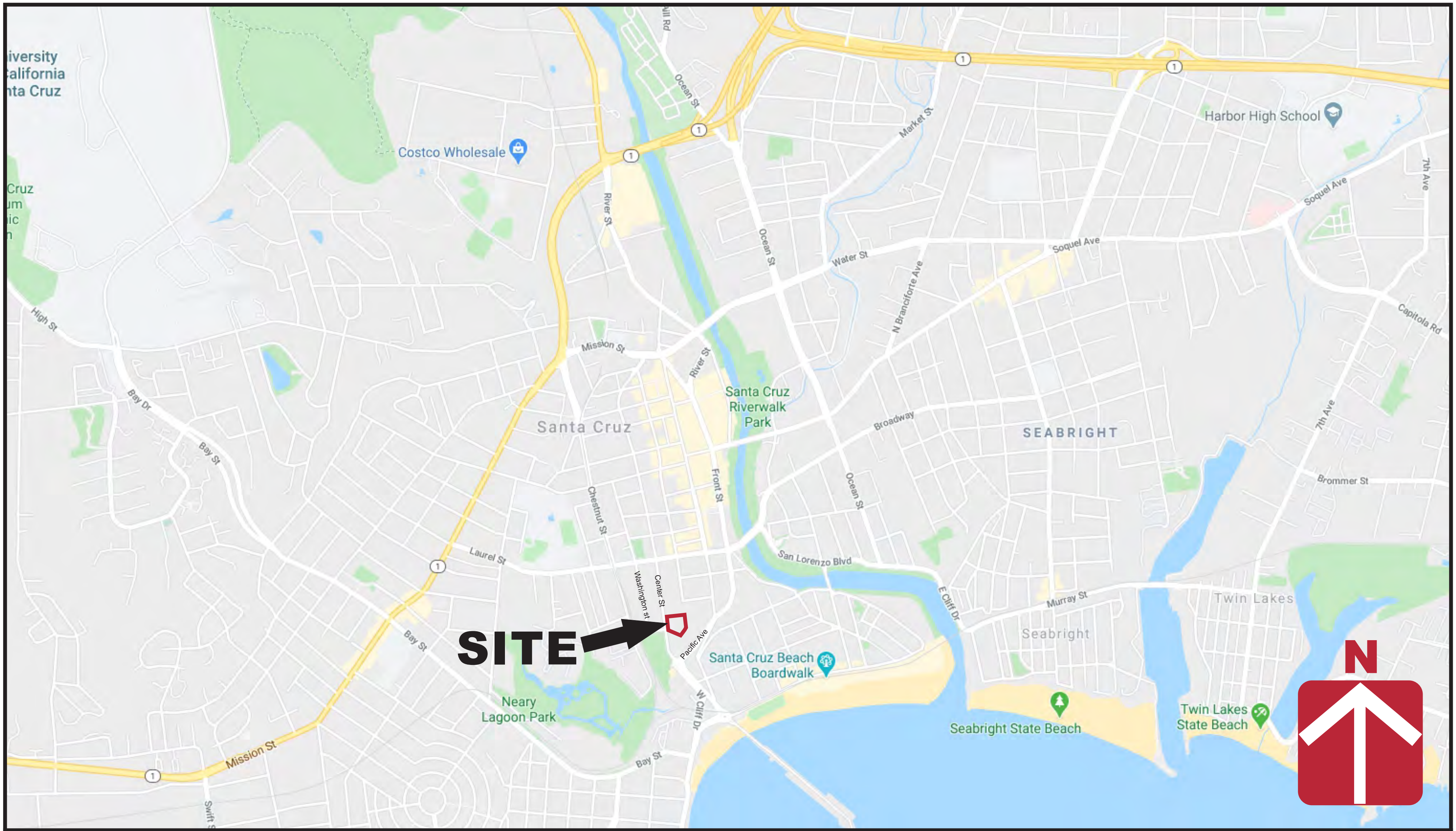

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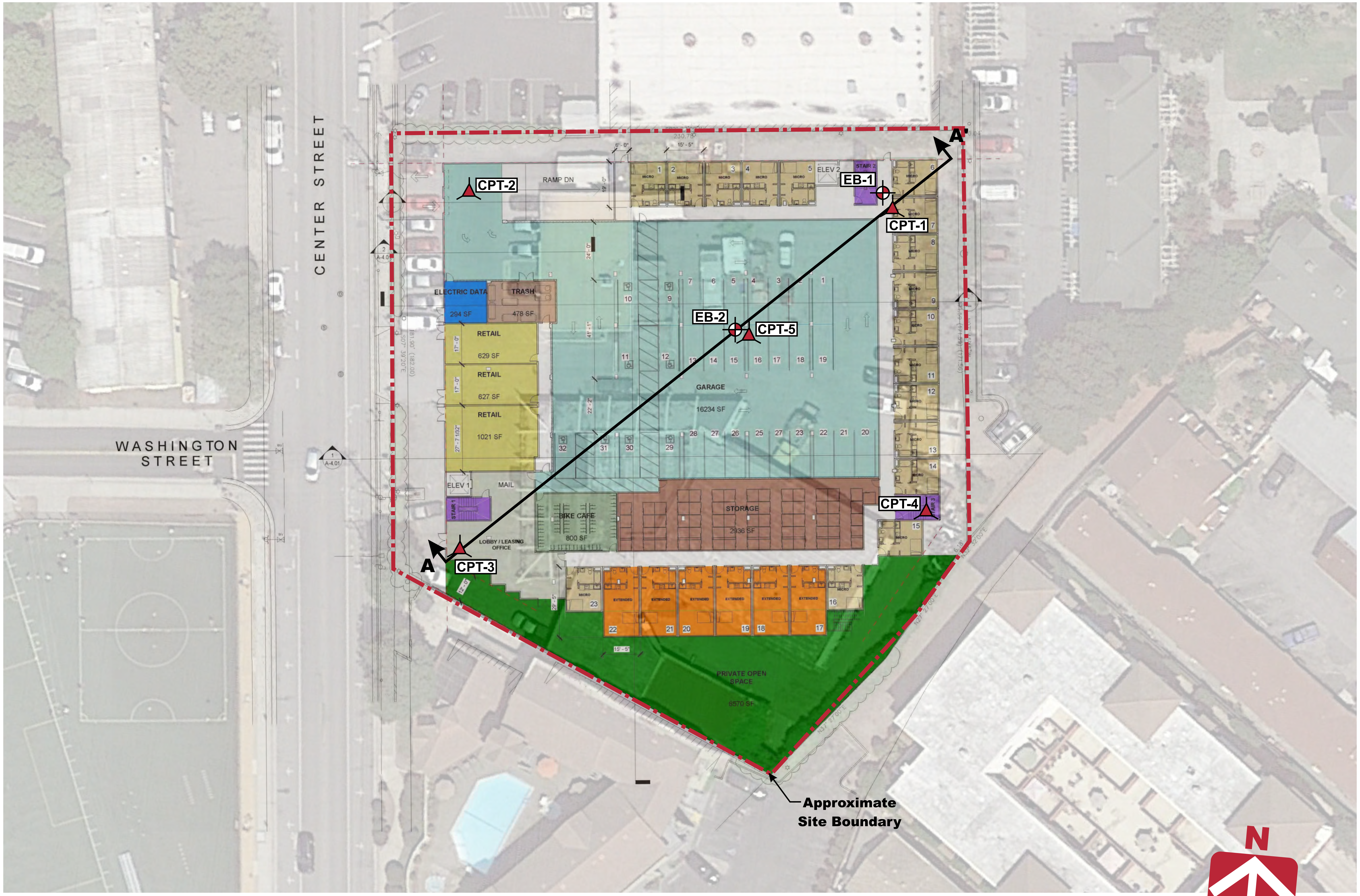
Vicinity Map

130 Center Street
Santa Cruz, CA

Project Number	100-65-1
Figure Number	Figure 1
Date	July 2020
Drawn By	RRN



Legend

⊕ Approximate location of exploratory boring (EB)

▲ Approximate location of cone penetration test (CPT)

A A' Approximate location of cross section

0 40 80
APPROXIMATE SCALE (FEET)

Base by Google Earth, dated 08/09/2018
Overlay by Swenson, First Floor - A-2.01, dated 02/19/2020

Project Number 100-65-1

Figure Number Figure 2

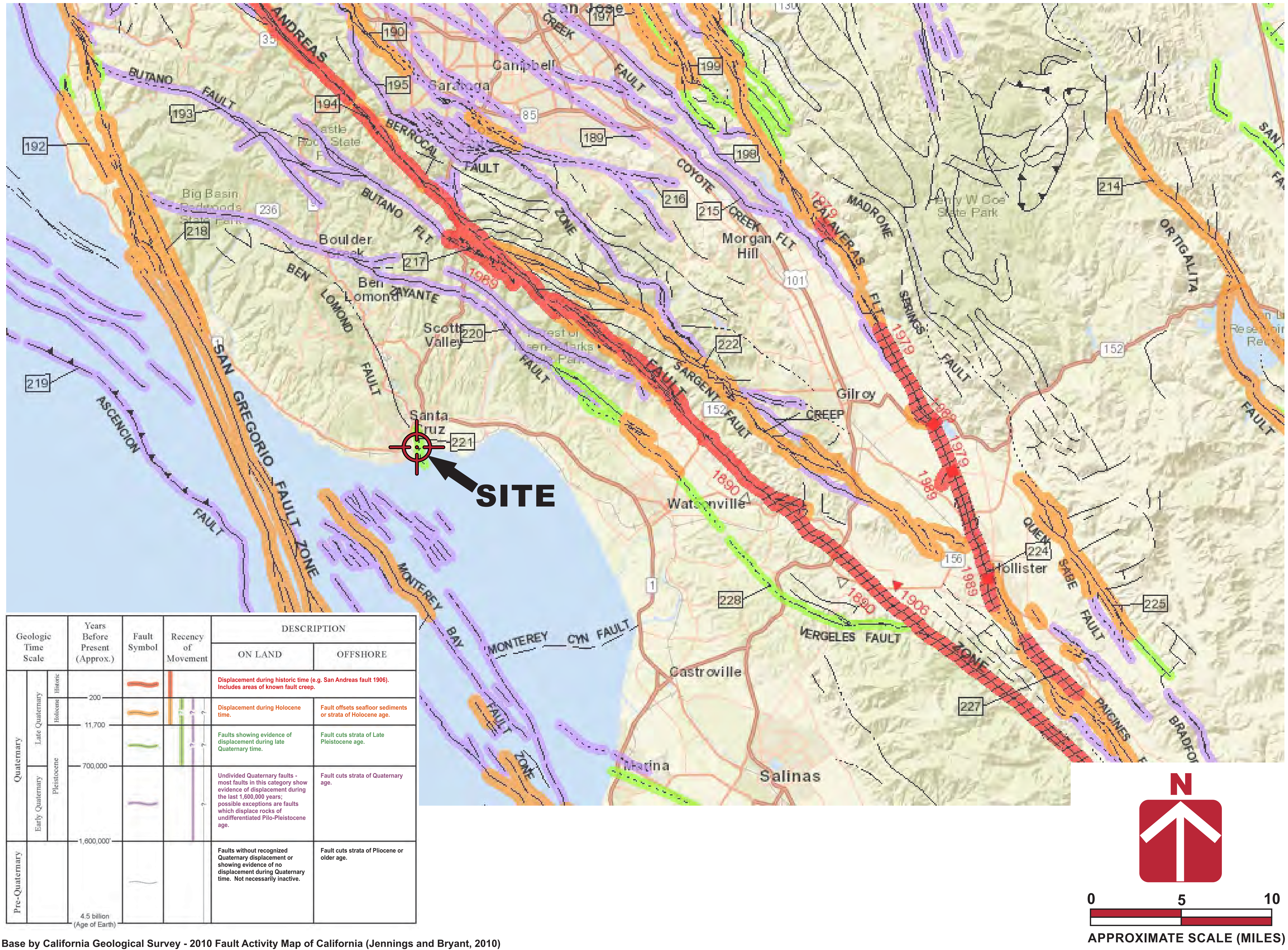
Date August 2020

Drawn By RRN

Site Plan

130 Center Street
Santa Cruz, CA

CORNERSTONE EARTH GROUP



Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION	
						ON LAND	OFFSHORE
Quaternary	Late Quaternary	Historic		🟥		Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	200	🟧	? ? ?	Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	11,700	🟩	? ?	Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Late Pleistocene age.
	Early Quaternary		700,000	🟪	?	Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Pilo-Pleistocene age.	Fault cuts strata of Quaternary age.
Pre-Quaternary			1,600,000* 4.5 billion (Age of Earth)	~		Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.

Base by California Geological Survey - 2010 Fault Activity Map of California (Jennings and Bryant, 2010)

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Regional Fault Map

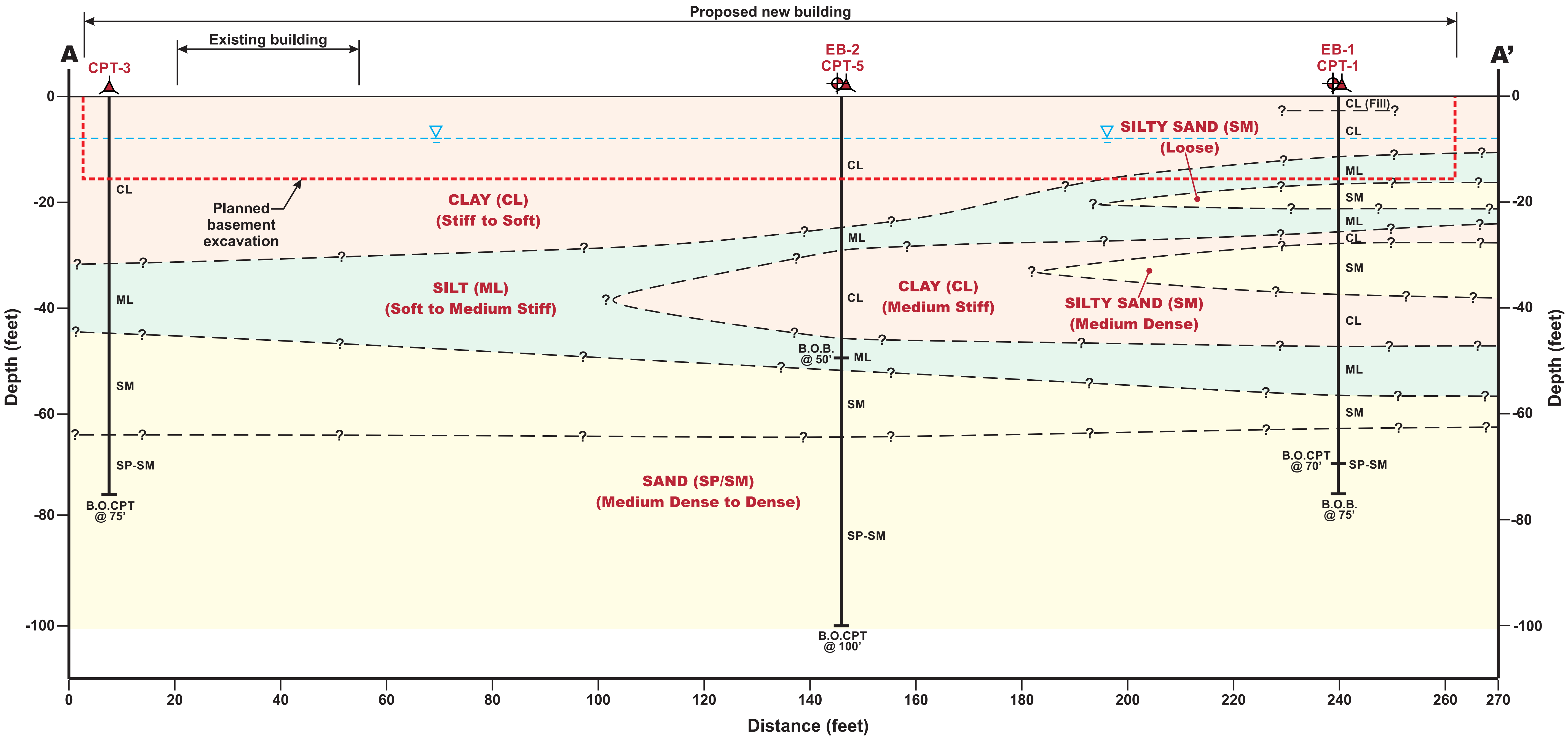
130 Center Street
Santa Cruz, CA

Project Number
100-65-1

Figure Number
Figure 3

Date
July 2020

Drawn By
RRN



Section A-A'

(View Looking Northwest)
1"=20' H:V

Symbols

CL	Lean Clay or sandy clay
ML	Silt
SM	Silty Sand
SP-SM	Poorly Graded Sand with Silt
▽	Approximate groundwater level; actual depth may vary
⊕	Approximate location of exploratory boring (EB)
▲	Approximate location of cone penetration test (CPT)

Notes:
1) Surficial fills associated with existing pavements, landscaping or utilities are not shown.
2) The subsurface profile is conceptual and is based on limited subsurface data obtained from widely spaced borings/CPT. Actual subsurface conditions may vary significantly between borings/CPT.
3) See Figure 2 for location of cross section.

CORNERSTONE EARTH GROUP

Generalized Cross Section A-A'

130 Center Street
Santa Cruz, CA

Project Number 100-65-1

Figure Number Figure 4

Date September 2020

Drawn By RRN

APPENDIX A: FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using truck-mounted, hollow-stem rotary wash auger drilling equipment and 20-ton truck-mounted Cone Penetration Test equipment. Two 8-inch-diameter exploratory borings were drilled on July 20th, 2020 to depths of 50 to 75 feet. Five CPT soundings were also performed in accordance with ASTM D 5778-95 (revised, 2002) on July 9th and July 10th, to depths ranging from 50 to 100 feet. The approximate locations of exploratory borings and CPTs are shown on the Site Plan, Figure 2. The soils encountered were continuously logged in the field by our representative and described in accordance with the Unified Soil Classification System (ASTM D2488). Boring logs, as well as a key to the classification of the soil and bedrock, are included as part of this appendix.

Boring and CPT locations were approximated using existing site boundaries. Boring and CPT elevations were based on interpolation of plan contours were not determined. The locations of the borings and CPTs should be considered accurate only to the degree implied by the method used.

Representative soil samples were obtained from the borings at selected depths. All samples were returned to our laboratory for evaluation and appropriate testing. The standard penetration resistance blow counts were obtained by dropping a 140-pound hammer through a 30-inch free fall. The 2-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration (ASTM D1586). 2.5-inch I.D. samples were obtained using a Modified California Sampler driven into the soil with the 140-pound hammer previously described. Relatively undisturbed samples were also obtained with 2.875-inch I.D. Shelby Tube sampler which were hydraulically pushed. Unless otherwise indicated, the blows per foot recorded on the boring log represent the accumulated number of blows required to drive the last 12 inches. The various samplers are denoted at the appropriate depth on the boring logs.

The CPT involved advancing an instrumented cone-tipped probe into the ground while simultaneously recording the resistance at the cone tip (q_c) and along the friction sleeve (f_s) at approximately 5-centimeter intervals. Based on the tip resistance and tip to sleeve ratio (R_f), the CPT classified the soil behavior type and estimated engineering properties of the soil, such as equivalent Standard Penetration Test (SPT) blow count, internal friction angle within sand layers, and undrained shear strength in silts and clays. A pressure transducer behind the tip of the CPT cone measured pore water pressure (u_2). Graphical logs of the CPT data is included as part of this appendix.

Field tests included an evaluation of the unconfined compressive strength of the soil samples using a pocket penetrometer device. The results of these tests are presented on the individual boring logs at the appropriate sample depths.

Attached boring and CPT logs and related information depict subsurface conditions at the locations indicated and on the date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these boring and CPT locations. The passage of time may result in altered subsurface conditions due to environmental changes. In addition, any stratification lines on the logs represent the approximate boundary between soil types and the transition may be gradual.

UNIFIED SOIL CLASSIFICATION (ASTM D-2487-98)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	Cu>4 AND 1<Cc<3	GW	WELL-GRADED GRAVEL
			Cu>4 AND 1>Cc>3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR CL	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES ON NO 4. SIEVE	CLEAN SANDS <5% FINES	Cu>6 AND 1<Cc<3	SW	WELL-GRADED SAND
			Cu>6 AND 1>Cc>3	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR CL	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

OTHER MATERIAL SYMBOLS

- Poorly-Graded Sand with Clay
- Clayey Sand
- Sandy Silt
- Artificial/Undocumented Fill
- Poorly-Graded Gravelly Sand
- Topsoil
- Well-Graded Gravel with Clay
- Well-Graded Gravel with Silt
- Sand
- Silt
- Well Graded Gravelly Sand
- Gravelly Silt
- Asphalt
- Boulders and Cobble

SAMPLER TYPES

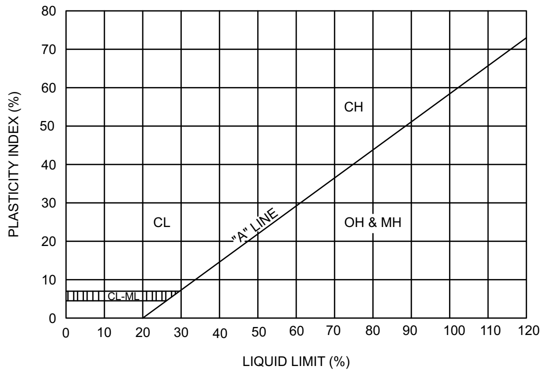
- ☒ SPT
- Modified California (2.5" I.D.)
- Rock Core
- ■ Shelby Tube
- ○ No Recovery
- Grab Sample

ADDITIONAL TESTS

CA - CHEMICAL ANALYSIS (CORROSIVITY)
CD - CONSOLIDATED DRAINED TRIAXIAL
CN - CONSOLIDATION
CU - CONSOLIDATED UNDRAINED TRIAXIAL
DS - DIRECT SHEAR
PP - POCKET PENETROMETER (TSF)
(3.0) - (WITH SHEAR STRENGTH IN KSF)
RV - R-VALUE
SA - SIEVE ANALYSIS: % PASSING #200 SIEVE
▼ - WATER LEVEL

PI - PLASTICITY INDEX
SW SWELL TEST
TC - CYCLIC TRIAXIAL
TV - TORVANE SHEAR
UC - UNCONFINED COMPRESSION
(1.5) - (WITH SHEAR STRENGTH IN KSF)
UU - UNCONSOLIDATED UNDRAINED TRIAXIAL

PLASTICITY CHART



PENETRATION RESISTANCE (RECORDED AS BLOWS / FOOT)				
SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	STRENGTH** (KSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.5
MEDIUM DENSE	10 - 30	MEDIUM STIFF	4 - 8	0.5-1.0
DENSE	30 - 50	STIFF	8 - 15	1.0 - 2.0
VERY DENSE	OVER 50	VERY STIFF	15 - 30	2.0 - 4.0
		HARD	OVER 30	OVER 4.0

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

** UNDRAINED SHEAR STRENGTH IN KIPS/SQ. FT. AS DETERMINED BY LABORATORY TESTING OR APPROXIMATED BY THE STANDARD PENETRATION TEST, POCKET PENETROMETER, TORVANE, OR VISUAL OBSERVATION.

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LEGEND TO SOIL DESCRIPTIONS

Figure Number
A-1

BORING NUMBER EB-1

PAGE 1 OF 3

CORNERSTONE EARTH GROUP

PROJECT NAME 130 Center Street
PROJECT NUMBER 100-65-1
PROJECT LOCATION Santa Cruz, CA

DATE STARTED 7/20/20 **DATE COMPLETED** 7/20/20
GROUND ELEVATION **BORING DEPTH** 75 ft.
DRILLING CONTRACTOR Pitcher Drilling
LATITUDE **LONGITUDE**
DRILLING METHOD Failing 1500, 6 inch Rotary wash
GROUND WATER LEVELS:
LOGGED BY DL
▽ **AT TIME OF DRILLING** 8 ft.
NOTES
▼ **AT END OF DRILLING** 8 ft.

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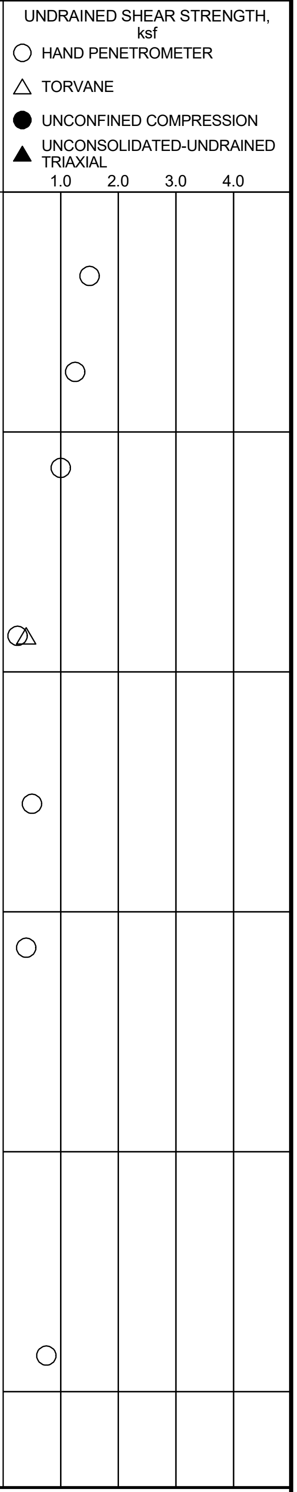
ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	N-Value (uncorrected) blows per foot	SAMPLES TYPE AND NUMBER	DRY UNIT WEIGHT PCF	NATURAL MOISTURE CONTENT	PLASTICITY INDEX, %	PERCENT PASSING No. 200 SIEVE
	0	1 inch of asphalt concrete over 3 inches aggregate base						
		Sandy Lean Clay (CL) [Fill} stiff, moist, dark brown and brown mottled, some fine sand, some angular to subangular gravel, moderate plasticity	18	MC-1B	95	21		
		Lean Clay with Sand (CL) stiff, moist, dark brown, fine sand, moderate plasticity	9	MC-2B	88	27		
	5		9	MC-3B	93	26		
▼		**Fat Clay (CH)** soft, moist, gray with brown mottles, some fine sand, trace organics, high plasticity	3	MC-4B	72	50		
	10							
		Sandy Silt (ML) medium stiff, moist, gray, fine sand NP= non plastic	4	SPT-5		37	NP	54
		Silt with Sand (ML) soft, moist, gray, fine sand, low plasticity						
	15		1	SPT-6		39		77
		Silty Sand (SM) loose, wet, gray, fine sand	8	MC-7B	84	31		48
			9	SPT-8		28		44
	20							
		Silt (ML) medium stiff, moist, gray, fine sand						
		NP= non plastic 9% Sand, 79% Silt, 12% Clay	6	MC-9B	85	34	NP	91
	25							



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PROJECT NAME 130 Center Street
PROJECT NUMBER 100-65-1
PROJECT LOCATION Santa Cruz, CA

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UNDRAINED SHEAR STRENGTH, ksf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
1.0 2.0 3.0 4.0

ELEVATION (ft)	DEPTH (ft)	SYMBOL	DESCRIPTION	N-Value (uncorrected) blows per foot	SAMPLES TYPE AND NUMBER	DRY UNIT WEIGHT PCF	NATURAL MOISTURE CONTENT	PLASTICITY INDEX, %	PERCENT PASSING No. 200 SIEVE	UNDRAINED SHEAR STRENGTH, ksf
			Lean Clay (CL) medium stiff, moist, gray, trace fine sand, moderate plasticity							○
			Silty Sand (SM) medium dense, moist, gray, coarse sand, some fine to coarse subangular to subrounded gravel	25	MC-10B	115	17		17	
				23	SPT-11		11		13	
	30									
				30	SPT-12		13		13	
			Poorly Graded Sand with Silt (SP-SM) medium dense, wet, gray, fine to medium sand	14	SPT-13		21		10	
	35									
			Silty Sand (SM) medium dense, moist, gray, fine to coarse sand	17	SPT-14		19		13	
			Lean Clay (CL) medium stiff, moist, gray, some fine sand, low plasticity Liquid Limit = 31, Plastic Limit = 19 12% Sand, 69% Silt, 19% Clay	7	MC-15B	93	30	12	88	○
	40									
				14	MC-16B	87	34			○ △
	45									
			Silt (ML) medium stiff to stiff, moist, gray, some fine sand, low plasticity 10% Sand, 74% Silt, 16% Clay	15	MC-17B	96	25		90	○
	50									
				13	MC-18B	91	31			○
	55									

Continued Next Page

BORING NUMBER EB-1

PROJECT NAME 130 Center Street

PROJECT NUMBER 100-65-1

PROJECT LOCATION Santa Cruz, CA

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UNDRAINED SHEAR STRENGTH, ksf
○ HAND PENETROMETER
△ TORVANE
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL
1.0 2.0 3.0 4.0

ELEVATION (ft)	DEPTH (ft)	SYMBOL	DESCRIPTION	N-Value (uncorrected) blows per foot	SAMPLES TYPE AND NUMBER	DRY UNIT WEIGHT PCF	NATURAL MOISTURE CONTENT	PLASTICITY INDEX, %	PERCENT PASSING No. 200 SIEVE	UNDRAINED SHEAR STRENGTH, ksf
			Silty Sand (SM) medium dense, moist, gray, fine sand							
				32	MC-19B	100	25		39	
	60									
			Poorly Graded Sand with Silt (SP-SM) medium dense, wet, gray and brown, fine to medium sand							
				40	MC					
	65									
				37	MC-21B	101	26			
	70									
				29	SPT-22		20			
	75		Bottom of Boring at 75.0 feet.							
	80									
	85									

CORNERSTONE EARTH GROUP

BORING NUMBER EB-2

PAGE 1 OF 2

PROJECT NAME 130 Center Street
PROJECT NUMBER 100-65-1
PROJECT LOCATION Santa Cruz, CA
DATE STARTED 7/20/20 **DATE COMPLETED** 7/20/20
GROUND ELEVATION **BORING DEPTH** 50 ft.
DRILLING CONTRACTOR Pitcher Drilling
LATITUDE **LONGITUDE**
DRILLING METHOD Failing 1500, 6 inch Rotary wash
GROUND WATER LEVELS:
LOGGED BY DL
∇ **AT TIME OF DRILLING** Not Encountered
NOTES
▼ **AT END OF DRILLING** Not Encountered

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ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	N-Value (uncorrected) blows per foot	SAMPLES TYPE AND NUMBER	DRY UNIT WEIGHT PCF	NATURAL MOISTURE CONTENT	PLASTICITY INDEX, %	PERCENT PASSING No. 200 SIEVE
	0	1 inch of asphalt concrete over 3 inches aggregate base						
		Lean Clay with Sand (CL) stiff, moist, dark brown, fine sand, moderate plasticity	12	MC-1B	88	25		
			9	MC-2B	94	25		
	5	**Lean CLay (CL)** medium stiff, moist, gray with brown mottles, some fine sand, moderate plasticity	8	MC-3B	89	29		
		becomes soft	0	MC-4B	83	36		
	10	*Shelby tube down pressure [50 psi]*		ST				
		Shelby tube down pressure [75 psi]						
		some dark gray mottles Liquid Limit = 36, Plastic Limit = 20	1	MC-6B	88	33	16	
	15							
		Shelby tube down pressure [60 psi]		ST-7	87	34		
	20	*Shelby tube down pressure [80 psi]*						
		Liquid Limit = 39, Plastic Limit = 20	3	MC-8B	88	34	19	
		Sandy Lean Clay (CL) stiff, moist, gray, fine sand, low plasticity *Shelby tube down pressure [80 psi]*		ST				
	25	*Shelby tube down pressure [100 psi]*						

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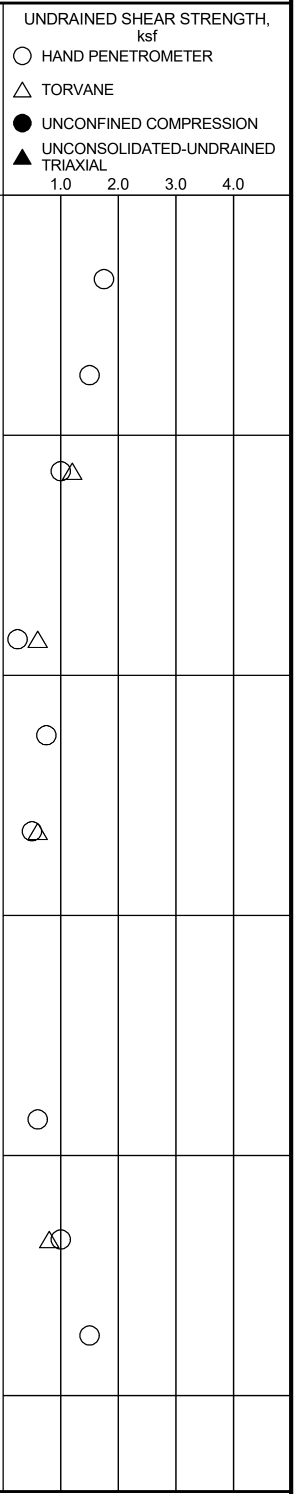

CORNERSTONE
EARTH GROUP

BORING NUMBER EB-2

PAGE 2 OF 2

PROJECT NAME 130 Center Street
PROJECT NUMBER 100-65-1
PROJECT LOCATION Santa Cruz, CA

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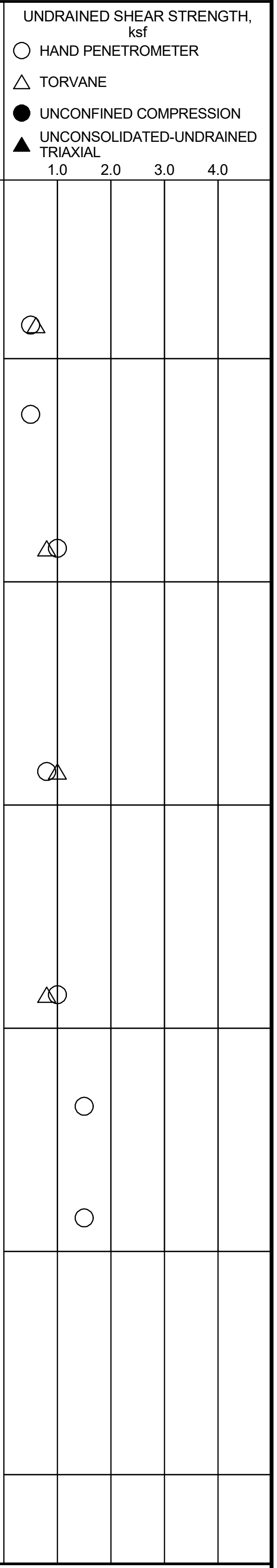
DESCRIPTION	N-Value (uncorrected) blows per foot	SAMPLES TYPE AND NUMBER	DRY UNIT WEIGHT PCF	NATURAL MOISTURE CONTENT	PLASTICITY INDEX, %	PERCENT PASSING No. 200 SIEVE
Sandy Silt (ML) medium stiff, moist, gray, fine sand, non plastic						
Lean Clay (CL) medium stiff, moist, gray with brown mottles, some fine sand, moderate plasticity	9	MC-10B	85	36		
Shelby tube down pressure [60 psi] *Shelby tube down pressure [80 psi]*		ST-11	85	35		
Liquid Limit = 38, Plastic Limit = 19	3	MC-12B	89	31	19	
	4	MC-13B	89	32		
	4	MC-14B	83	38		
Sandy Silt (ML) stiff, moist, gray, fine sand, non plastic	21	SPT-15		29		50
	25	MC-16B	96	25		
Bottom of Boring at 50.0 feet.						



GREGG DRILLING, LLC.
GEOTECHNICAL AND ENVIRONMENTAL INVESTIGATION SERVICES

July 13, 2020

Cornerstone
Attn: Diana Lin

Subject: CPT Site Investigation
130 Center Street
Santa Cruz, California
GREGG Project Number: D2209133

Dear Ms. Lin:

The following report presents the results of GREGG Drilling Cone Penetration Test investigation for the above referenced site. The following testing services were performed:

1	Cone Penetration Tests	(CPTU)	☒
2	Pore Pressure Dissipation Tests	(PPD)	☒
3	Seismic Cone Penetration Tests	(SCPTU)	☒
4	UVOST Laser Induced Fluorescence	(UVOST)	☐
5	Groundwater Sampling	(GWS)	☐
6	Soil Sampling	(SS)	☐
7	Vapor Sampling	(VS)	☐
8	Pressuremeter Testing	(PMT)	☐
9	Vane Shear Testing	(VST)	☐
10	Dilatometer Testing	(DMT)	☐

A list of reference papers providing additional background on the specific tests conducted is provided in the bibliography following the text of the report. If you would like a copy of any of these publications or should you have any questions or comments regarding the contents of this report, please do not hesitate to contact me at 714-863-0988.

Sincerely,
Gregg Drilling, LLC.

CPT Reports Team
Gregg Drilling, LLC.

2726 Walnut Ave. • Signal Hill, California 90755 • (562) 427-6899 • FAX (562) 427-3314
950 Howe Road. • Martinez, California 94553 • (925) 313-5800 • FAX (925) 313-0302
www.greggdrilling.com

Cone Penetration Test Sounding Summary

-Table 1-

CPT Sounding Identification	Date	Termination Depth (feet)	Depth of Groundwater Samples (feet)	Depth of Soil Samples (feet)	Depth of Pore Pressure Dissipation Tests (feet)
CPT-01	7/9/2020	70.05	-	-	62.2
CPT-02	7/10/2020	50.03	-	-	-
CPT-03	7/10/2020	75.62	-	-	46.1
CPT-04	7/9/2020	50.2	-	-	-
CPT-05	7/9/2020	100.23	-	-	46.8, 76.9

Bibliography

Lunne, T., Robertson, P.K. and Powell, J.J.M., “Cone Penetration Testing in Geotechnical Practice” E & FN Spon. ISBN 0 419 23750, 1997

Roberston, P.K., “Soil Classification using the Cone Penetration Test”, Canadian Geotechnical Journal, Vol. 27, 1990 pp. 151-158.

Mayne, P.W., “NHI (2002) Manual on Subsurface Investigations: Geotechnical Site Characterization”, available through www.ce.gatech.edu/~geosys/Faculty/Mayne/papers/index.html, Section 5.3, pp. 107-112.

Robertson, P.K., R.G. Campanella, D. Gillespie and A. Rice, “Seismic CPT to Measure In-Situ Shear Wave Velocity”, Journal of Geotechnical Engineering ASCE, Vol. 112, No. 8, 1986 pp. 791-803.

Robertson, P.K., Sully, J., Woeller, D.J., Lunne, T., Powell, J.J.M., and Gillespie, D.J., "Guidelines for Estimating Consolidation Parameters in Soils from Piezocone Tests", Canadian Geotechnical Journal, Vol. 29, No. 4, August 1992, pp. 539-550.

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Campanella, R.G. and I. Weemees, “Development and Use of An Electrical Resistivity Cone for Groundwater Contamination Studies”, Canadian Geotechnical Journal, Vol. 27 No. 5, 1990 pp. 557-567.

DeGroot, D.J. and A.J. Lutenegger, “Reliability of Soil Gas Sampling and Characterization Techniques”, International Site Characterization Conference - Atlanta, 1998.

Woeller, D.J., P.K. Robertson, T.J. Boyd and Dave Thomas, “Detection of Polyaromatic Hydrocarbon Contaminants Using the UVIF-CPT”, 53rd Canadian Geotechnical Conference Montreal, QC October pp. 733-739, 2000.

Zemo, D.A., T.A. Delfino, J.D. Gallinatti, V.A. Baker and L.R. Hilpert, “Field Comparison of Analytical Results from Discrete-Depth Groundwater Samplers” BAT EnviroProbe and QED HydroPunch, Sixth national Outdoor Action Conference, Las Vegas, Nevada Proceedings, 1992, pp 299-312.

Copies of ASTM Standards are available through www.astm.org

Cone Penetration Testing Procedure (CPT)

Gregg Drilling carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*.

The cone takes measurements of tip resistance (q_c), sleeve resistance (f_s), and penetration pore water pressure (u_2). Measurements are taken at either 2.5 or 5 cm intervals during penetration to provide a nearly continuous profile. CPT data reduction and basic interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored electronically for further analysis and reference. All CPT soundings are performed in accordance with revised ASTM standards (D 5778-12).

The 5mm thick porous plastic filter element is located directly behind the cone tip in the u_2 location. A new saturated filter element is used on each sounding to measure both penetration pore pressures as well as measurements during a dissipation test (*PPDT*). Prior to each test, the filter element is fully saturated with oil under vacuum pressure to improve accuracy.

When the sounding is completed, the test hole is backfilled according to client specifications. If grouting is used, the procedure generally consists of pushing a hollow tremie pipe with a "knock out" plug to the termination depth of the CPT hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

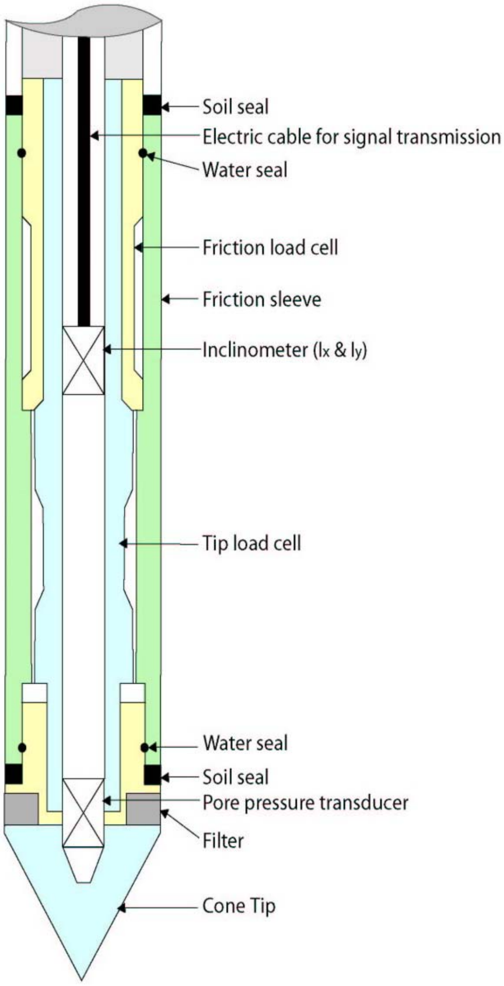


Figure CPT

Gregg 15cm^2 Standard Cone Specifications

Dimensions	
Cone base area	15 cm^2
Sleeve surface area	225 cm^2
Cone net area ratio	0.80
Specifications	
Cone load cell	
Full scale range	180 kN (20 tons)
Overload capacity	150%
Full scale tip stress	120 MPa (1,200 tsf)
Repeatability	120 kPa (1.2 tsf)
Sleeve load cell	
Full scale range	31 kN (3.5 tons)
Overload capacity	150%
Full scale sleeve stress	1,400 kPa (15 tsf)
Repeatability	1.4 kPa (0.015 tsf)
Pore pressure transducer	
Full scale range	7,000 kPa (1,000 psi)
Overload capacity	150%
Repeatability	7 kPa (1 psi)

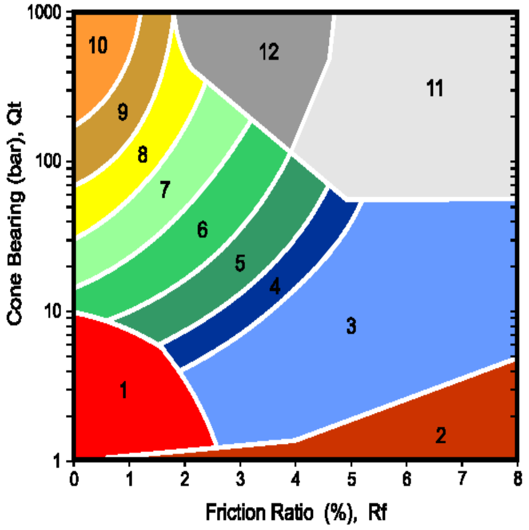
Note: The repeatability during field use will depend somewhat on ground conditions, abrasion, maintenance and zero load stability.

Cone Penetration Test Data & Interpretation

The Cone Penetration Test (CPT) data collected are presented in graphical and electronic form in the report. The plots include interpreted Soil Behavior Type (SBT) based on the charts described by Robertson (1990). Typical plots display SBT based on the non-normalized charts of Robertson et al (1986). For CPT soundings deeper than 30m, we recommend the use of the normalized charts of Robertson (1990) which can be displayed as SBTn, upon request. The report also includes spreadsheet output of computer calculations of basic interpretation in terms of SBT and SBTn and various geotechnical parameters using current published correlations based on the comprehensive review by Lunne, Robertson and Powell (1997), as well as recent updates by Professor Robertson (Guide to Cone Penetration Testing, 2015). The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg Drilling & Testing Inc. does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software. Some interpretation methods require input of the groundwater level to calculate vertical effective stress. An estimate of the in-situ groundwater level has been made based on field observations and/or CPT results, but should be verified by the user.

A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Note that it is not always possible to clearly identify a soil type based solely on q_t, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the correct soil behavior type.



ZONE		SBT	
1		🟥	Sensitive, fine grained
2		🟫	Organic materials
3		🟦	Clay
4		🟦	Silty clay to clay
5		🟩	Clayey silt to silty clay
6		🟩	Sandy silt to clayey silt
7		🟩	Silty sand to sandy silt
8		🟨	Sand to silty sand
9		🟫	Sand
10		🟧	Gravely sand to sand
11		⬜	Very stiff fine grained*
12		⬛	Sand to clayey sand*

*over consolidated or cemented

Figure SBT (After Robertson et al., 1986) – Note: Colors may vary slightly compared to plots

Cone Penetration Test (CPT) Interpretation

Gregg uses a proprietary CPT interpretation and plotting software. The software takes the CPT data and performs basic interpretation in terms of soil behavior type (SBT) and various geotechnical parameters using current published empirical correlations based on the comprehensive review by Lunne, Robertson and Powell (1997). The interpretation is presented in tabular format using MS Excel. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed. Gregg does not warranty the correctness or the applicability of any of the geotechnical parameters interpreted by the software and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used in the software.

The following provides a summary of the methods used for the interpretation. Many of the empirical correlations to estimate geotechnical parameters have constants that have a range of values depending on soil type, geologic origin and other factors. The software uses 'default' values that have been selected to provide, in general, conservatively low estimates of the various geotechnical parameters.

Input:

1 Units for display (Imperial or metric) (atm. pressure, p_a = 0.96 tsf or 0.1 MPa)
2 Depth interval to average results (ft or m). Data are collected at either 0.02 or 0.05m and can be averaged every 1, 3 or 5 intervals.
3 Elevation of ground surface (ft or m)
4 Depth to water table, z_w (ft or m) – input required
5 Net area ratio for cone, a (default to 0.80)
6 Relative Density constant, C_{Dr} (default to 350)
7 Young's modulus number for sands, α (default to 5)
8 Small strain shear modulus number
  a. for sands, S_G (default to 180 for SBT_n 5, 6, 7)
  b. for clays, C_G (default to 50 for SBT_n 1, 2, 3 & 4)
9 Undrained shear strength cone factor for clays, N_{kt} (default to 15)
10 Over Consolidation ratio number, k_{ocr} (default to 0.3)
11 Unit weight of water, (default to γ_w = 62.4 lb/ft^3 or 9.81 kN/m^3)

Column

1 Depth, z, (m) – CPT data is collected in meters
2 Depth (ft)
3 Cone resistance, q_c (tsf or MPa)
4 Sleeve resistance, f_s (tsf or MPa)
5 Penetration pore pressure, u (psi or MPa), measured behind the cone (i.e. u_2)
6 Other – any additional data
7 Total cone resistance, q_t (tsf or MPa) $q_t = q_c + u\,(1-a)$

8	Friction Ratio, R_f (%)	$R_f = (f_s/q_t) \times 100\%$
9	Soil Behavior Type (non-normalized), SBT	see note
10	Unit weight, γ (pcf or kN/m^3)	based on SBT, see note
11	Total overburden stress, σ_v (tsf)	$\sigma_{vo} = \sigma\ z$
12	In-situ pore pressure, u_o (tsf)	$u_o = \gamma_w (z - z_w)$
13	Effective overburden stress, σ'_{vo} (tsf)	$\sigma'_{vo} = \sigma_{vo} - u_o$
14	Normalized cone resistance, Q_{t1}	$Q_{t1} = (q_t - \sigma_{vo}) / \sigma'_{vo}$
15	Normalized friction ratio, F_r (%)	$F_r = f_s / (q_t - \sigma_{vo}) \times 100\%$
16	Normalized Pore Pressure ratio, B_q	$B_q = u – u_o / (q_t - \sigma_{vo})$
17	Soil Behavior Type (normalized), SBT_n	see note
18	SBT_n Index, I_c	see note
19	Normalized Cone resistance, Q_{tn} (n varies with I_c)	see note
20	Estimated permeability, k_{SBT} (cm/sec or ft/sec)	see note
21	Equivalent SPT N_{60}, blows/ft	see note
22	Equivalent SPT $(N_1)_{60}$ blows/ft	see note
23	Estimated Relative Density, D_r, (%)	see note
24	Estimated Friction Angle, ϕ', (degrees)	see note
25	Estimated Young's modulus, E_s (tsf)	see note
26	Estimated small strain Shear modulus, Go (tsf)	see note
27	Estimated Undrained shear strength, s_u (tsf)	see note
28	Estimated Undrained strength ratio	s_u/σ_v'
29	Estimated Over Consolidation ratio, OCR	see note

Notes:

1 Soil Behavior Type (non-normalized), SBT (Lunne et al., 1997 and table below)

2 Unit weight, γ either constant at 119 pcf or based on Non-normalized SBT (Lunne et al., 1997 and table below)

3 Soil Behavior Type (Normalized), SBT_n Lunne et al. (1997)

4 SBT_n Index, I_c $I_c = ((3.47 – \log Q_{t1})^2 + (\log F_r + 1.22)^2)^{0.5}$

5 Normalized Cone resistance, Q_{tn} (n varies with Ic)

$Q_{tn} = ((q_t - \sigma_{vo})/pa)\ (pa/(\sigma'_{vo})^n$ and recalculate I_c, then iterate:

When $I_c < 1.64$, n = 0.5 (clean sand)
When $I_c > 3.30$, n = 1.0 (clays)
When $1.64 < I_c < 3.30$, $n = (I_c – 1.64)0.3 + 0.5$
Iterate until the change in n, $\Delta n < 0.01$

6 Estimated permeability, k_{SBT} based on Normalized SBT_n (Lunne et al., 1997 and table below)

7 Equivalent SPT N_{60}, blows/ft Lunne et al. (1997)

$$\frac{(q_t/p_a)}{N_{60}} = 8.5 \left(1 - \frac{I_c}{4.6}\right)$$

8 Equivalent SPT $(N_1)_{60}$ blows/ft $(N_1)_{60} = N_{60}\,C_{N,}$

where $C_N = (pa/\sigma'_{vo})^{0.5}$

9 Relative Density, D_r, (%) $D_r^2 = Q_{tn} / C_{Dr}$

Only SBT_n *5, 6, 7 & 8* *Show 'N/A' in zones 1, 2, 3, 4 & 9*

10 Friction Angle, ϕ', (degrees) $\tan \phi' = \frac{1}{2.68}\left[\log\left(\frac{q_c}{\sigma'_{vo}}\right) + 0.29\right]$

Only SBT_n *5, 6, 7 & 8* *Show'N/A' in zones 1, 2, 3, 4 & 9*

11 Young's modulus, E_s $E_s = \alpha\, q_t$

Only SBT_n *5, 6, 7 & 8* *Show 'N/A' in zones 1, 2, 3, 4 & 9*

12 Small strain shear modulus, Go

a. $G_o = S_G\,(q_t\ \ \sigma'_{vo}\ pa)^{1/3}$ *For* SBT_n *5, 6, 7*

b. $G_o = C_G\, q_t$ *For* SBT_n *1, 2, 3& 4*

Show 'N/A' in zones 8 & 9

13 Undrained shear strength, s_u $s_u = (q_t - \sigma_{vo}) / N_{kt}$

Only SBT_n *1, 2, 3, 4 & 9* *Show 'N/A' in zones 5, 6, 7 & 8*

14 Over Consolidation ratio, OCR $OCR = k_{ocr}\, Q_{t1}$

Only SBT_n *1, 2, 3, 4 & 9* *Show 'N/A' in zones 5, 6, 7 & 8*

The following updated and simplified SBT descriptions have been used in the software:

SBT Zones		**SBT_n Zones**	
1	sensitive fine grained	1	sensitive fine grained
2	organic soil	2	organic soil
3	clay	3	clay
4	clay & silty clay	4	clay & silty clay
5	clay & silty clay		
6	sandy silt & clayey silt		

7	silty sand & sandy silt	5	silty sand & sandy silt
8	sand & silty sand	6	sand & silty sand
9	sand		
10	sand	7	sand
11	very dense/stiff soil*	8	very dense/stiff soil*
12	very dense/stiff soil*	9	very dense/stiff soil*

*heavily overconsolidated and/or cemented

Track when soils fall with zones of same description and print that description (i.e. if soils fall only within SBT zones 4 & 5, print 'clays & silty clays')

Estimated Permeability (see Lunne et al., 1997)

SBT_n	Permeability (ft/sec)	(m/sec)
1	$3x\ 10^{-8}$	$1x\ 10^{-8}$
2	$3x\ 10^{-7}$	$1x\ 10^{-7}$
3	$1x\ 10^{-9}$	$3x\ 10^{-10}$
4	$3x\ 10^{-8}$	$1x\ 10^{-8}$
5	$3x\ 10^{-6}$	$1x\ 10^{-6}$
6	$3x\ 10^{-4}$	$1x\ 10^{-4}$
7	$3x\ 10^{-2}$	$1x\ 10^{-2}$
8	$3x\ 10^{-6}$	$1x\ 10^{-6}$
9	$1x\ 10^{-8}$	$3x\ 10^{-9}$

Estimated Unit Weight (see Lunne et al., 1997)

SBT	Approximate Unit Weight (lb/ft^3)	(kN/m^3)
1	111.4	17.5
2	79.6	12.5
3	111.4	17.5
4	114.6	18.0
5	114.6	18.0
6	114.6	18.0
7	117.8	18.5
8	120.9	19.0
9	124.1	19.5
10	127.3	20.0
11	130.5	20.5
12	120.9	19.0

Pore Pressure Dissipation Tests (PPDT)

Pore Pressure Dissipation Tests (PPDT's) conducted at various intervals can be used to measure equilibrium water pressure (at the time of the CPT). If conditions are hydrostatic, the equilibrium water pressure can be used to determine the approximate depth of the ground water table. A PPDT is conducted when penetration is halted at specific intervals determined by the field representative. The variation of the penetration pore pressure (*u)* with time is measured behind the tip of the cone and recorded.

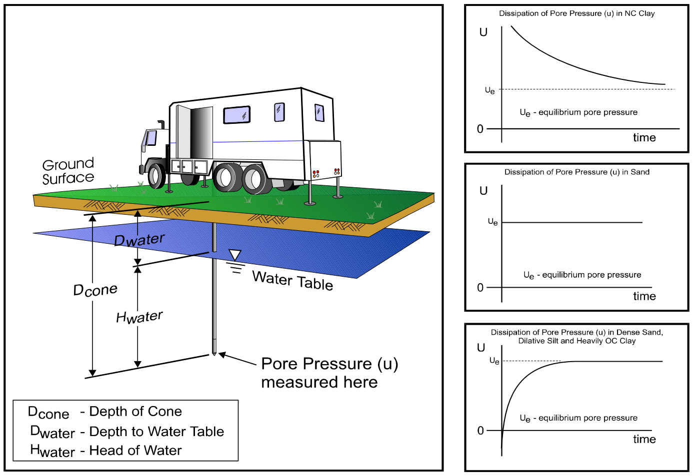
Pore pressure dissipation data can be interpreted to provide estimates of:

- Equilibrium piezometric pressure
- Phreatic Surface
- In situ horizontal coefficient of consolidation (c_h)
- In situ horizontal coefficient of permeability (k_h)

In order to correctly interpret the equilibrium piezometric pressure and/or the phreatic surface, the pore pressure must be monitored until it reaches equilibrium, *Figure PPDT*. This time is commonly referred to as t_{100}, the point at which 100% of the excess pore pressure has dissipated.

A complete reference on pore pressure dissipation tests is presented by Robertson et al. 1992 and Lunne et al. 1997.

A summary of the pore pressure dissipation tests are summarized in Table 1.



Water Table Calculation

$$D_{water} = D_{cone} - H_{water}$$

where $H_{water} = U_e$ (depth units)

Useful Conversion Factors:
1psi = 0.704m = 2.31 feet (water)
1tsf = 0.958 bar = 13.9 psi
1m = 3.28 feet

Figure PPDT

Seismic Cone Penetration Testing (SCPT)

Seismic Cone Penetration Testing (SCPT) can be conducted at various intervals during the Cone Penetration Test. Shear wave velocity (Vs) can then be calculated over a specified interval with depth. A small interval for seismic testing, such as 1-1.5m (3-5ft) allows for a detailed look at the shear wave profile with depth. Conversely, a larger interval such as 3-6m (10-20ft) allows for a more average shear wave velocity to be calculated. Gregg's cones have a horizontally active geophone located 0.2m (0.66ft) behind the tip.

To conduct the seismic shear wave test, the penetration of the cone is stopped and the rods are decoupled from the rig. An automatic hammer is triggered to send a shear wave into the soil. The distance from the source to the cone is calculated knowing the total depth of the cone and the horizontal offset distance between the source and the cone. To calculate an interval velocity, a minimum of two tests must be performed at two different depths. The arrival times between the two wave traces are compared to obtain the difference in time (Δt). The difference in depth is calculated (Δd) and velocity can be determined using the simple equation: v = Δd/Δt

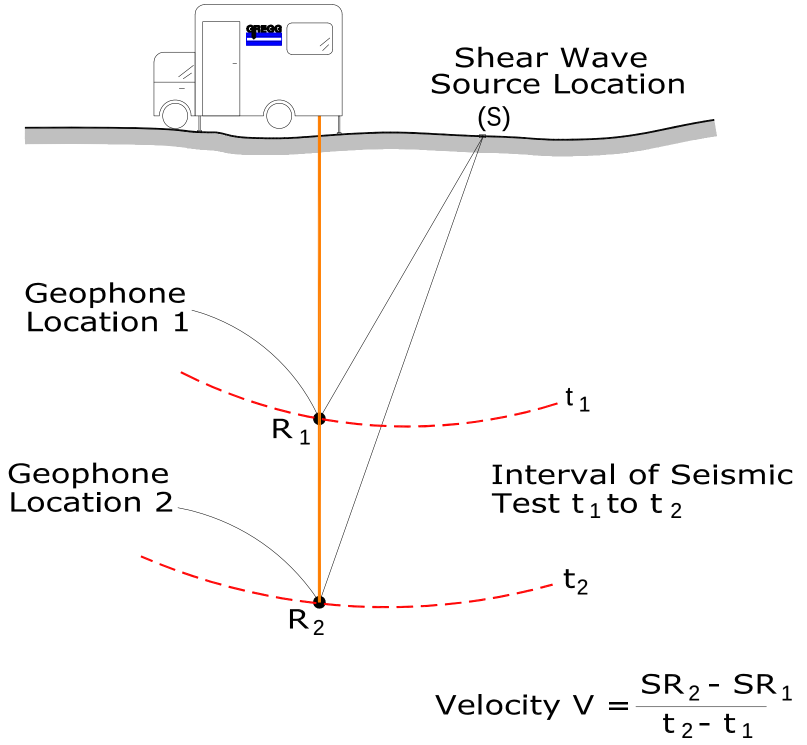


Figure SCPT

Multiple wave traces can be recorded at the same depth to improve quality of the data.

A complete reference on seismic cone penetration tests is presented by Robertson et al. 1986 and Lunne et al. 1997.

A summary the shear wave velocities, arrival times and wave traces are provided with the report.

Groundwater Sampling

Gregg Drilling & Testing, Inc. conducts groundwater sampling using a sampler as shown in *Figure GWS*. The groundwater sampler has a retrievable stainless steel or disposable PVC screen with steel drop off tip. This allows for samples to be taken at multiple depth intervals within the same sounding location. In areas of slower water recharge, provisions may be made to set temporary PVC well screens during sampling to allow the pushing equipment to advance to the next sample location while the groundwater is allowed to infiltrate.

The groundwater sampler operates by advancing 44.5mm (1¾ inch) hollow push rods with the filter tip in a closed configuration to the base of the desired sampling interval. Once at the desired sample depth, the push rods are retracted; exposing the encased filter screen and allowing groundwater to infiltrate hydrostatically from the formation into the inlet screen. A small diameter bailer (approximately ½ or ¾ inch) is lowered through the push rods into the screen section for sample collection. The number of downhole trips with the bailer and time necessary to complete the sample collection at each depth interval is a function of sampling protocols, volume requirements, and the yield characteristics and storage capacity of the formation. Upon completion of sample collection, the push rods and sampler, with the exception of the PVC screen and steel drop off tip are retrieved to the ground surface, decontaminated and prepared for the next sampling event.

For a detailed reference on direct push groundwater sampling, refer to Zemo et. al., 1992.

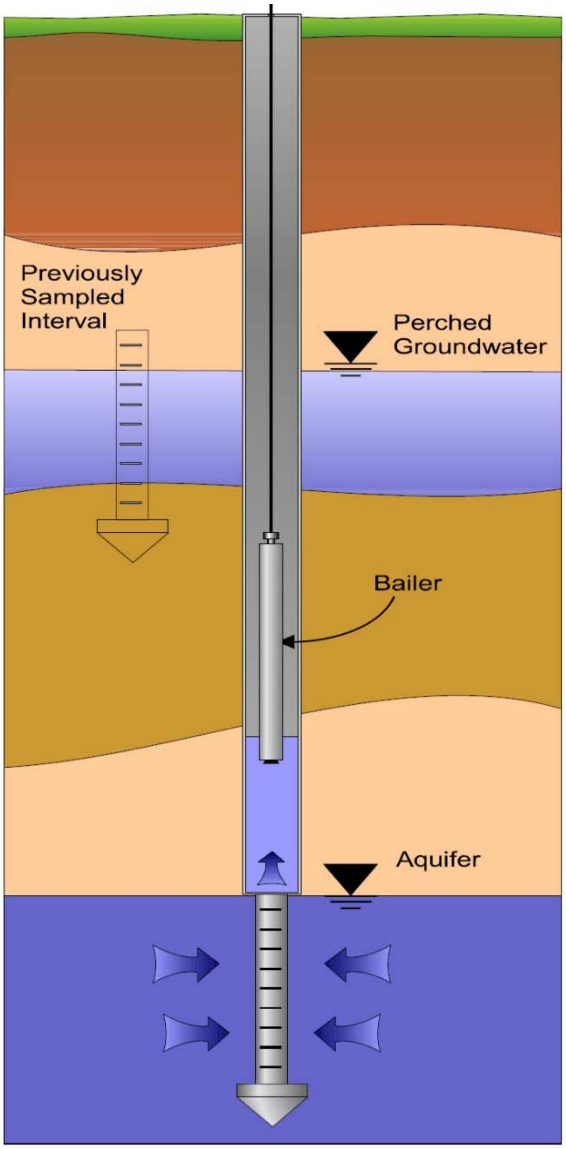


Figure GWS

Soil Sampling

Gregg Drilling & Testing, Inc. uses a piston-type push-in sampler to obtain small soil samples without generating any soil cuttings, *Figure SS*. Two different types of samplers (12 and 18 inch) are used depending on the soil type and density. The soil sampler is initially pushed in a "closed" position to the desired sampling interval using the CPT pushing equipment. Keeping the sampler closed minimizes the potential of cross contamination. The inner tip of the sampler is then retracted leaving a hollow soil sampler with inner 1¼" diameter sample tubes. The hollow sampler is then pushed in a locked "open" position to collect a soil sample. The filled sampler and push rods are then retrieved to the ground surface. Because the soil enters the sampler at a constant rate, the opportunity for 100% recovery is increased. For environmental analysis, the soil sample tube ends are sealed with Teflon and plastic caps. Often, a longer "split tube" can be used for geotechnical sampling.

For a detailed reference on direct push soil sampling, refer to Robertson et al, 1998.

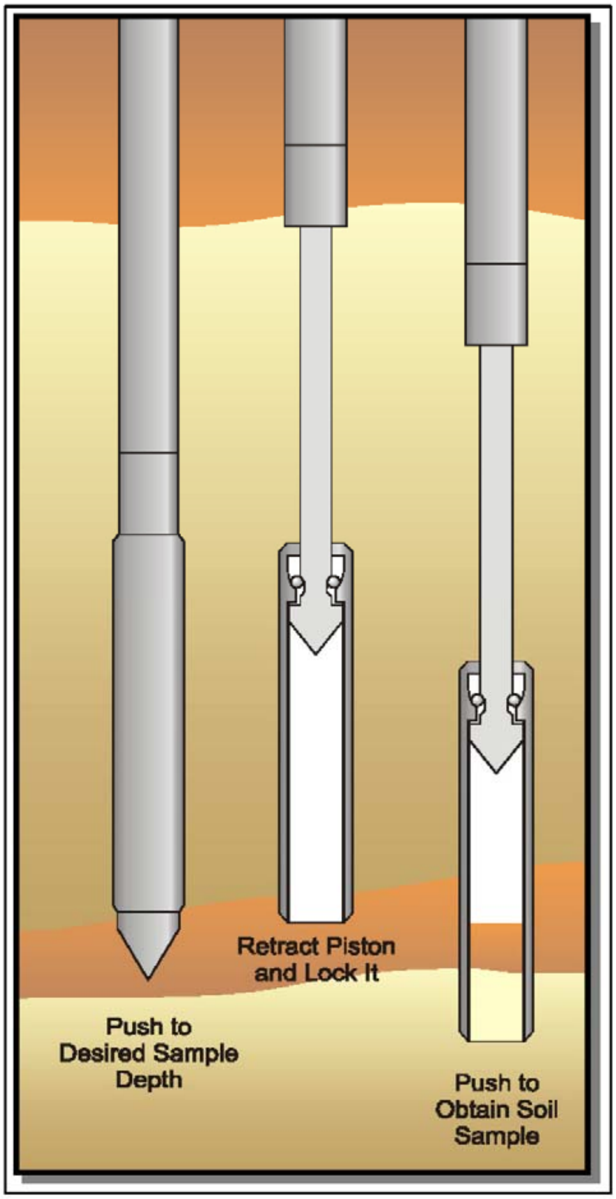


Figure SS

GREGG DRILLING, LLC
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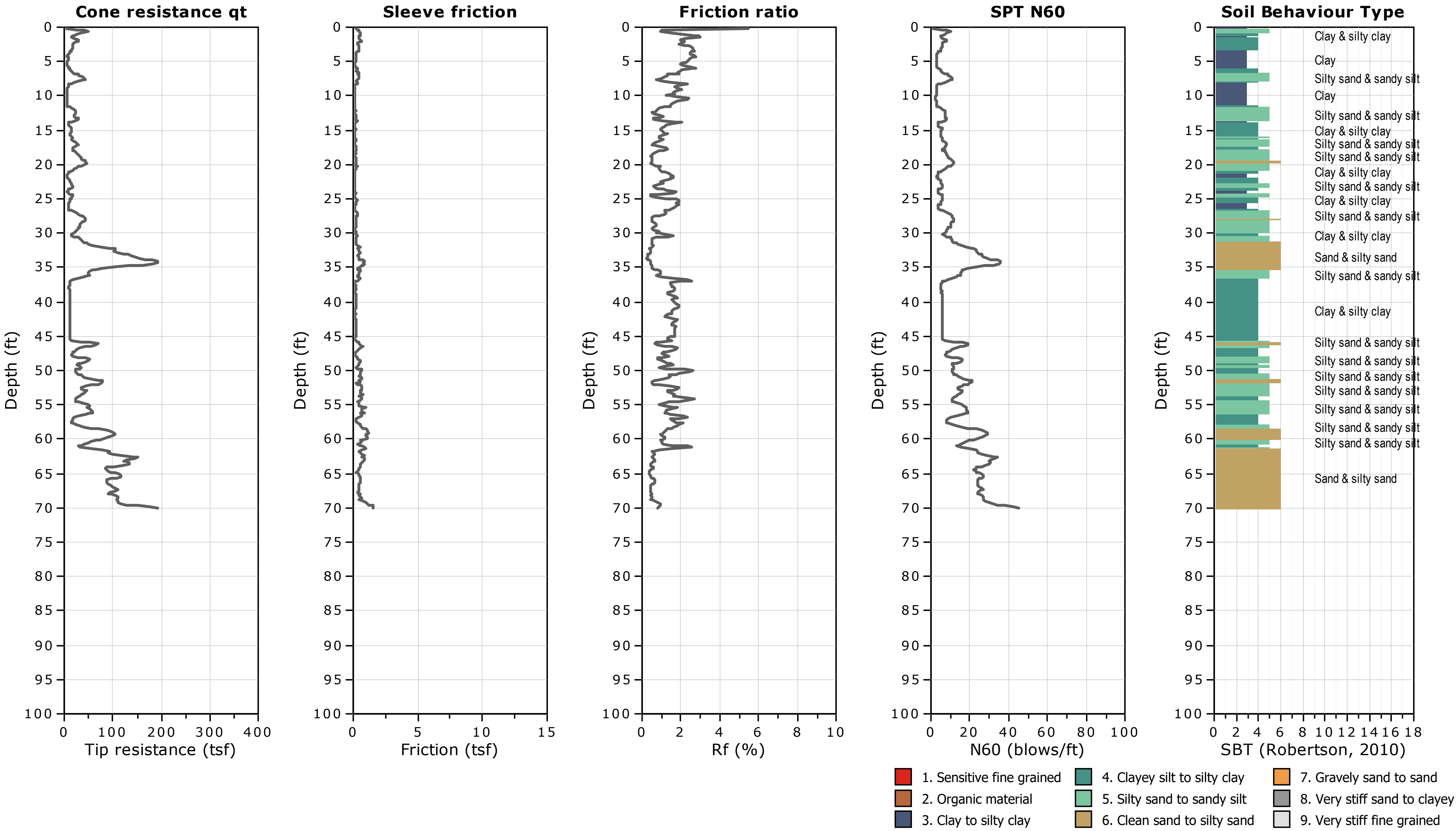
CPT: CPT-01

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 70.05 ft, Date: 7/9/2020

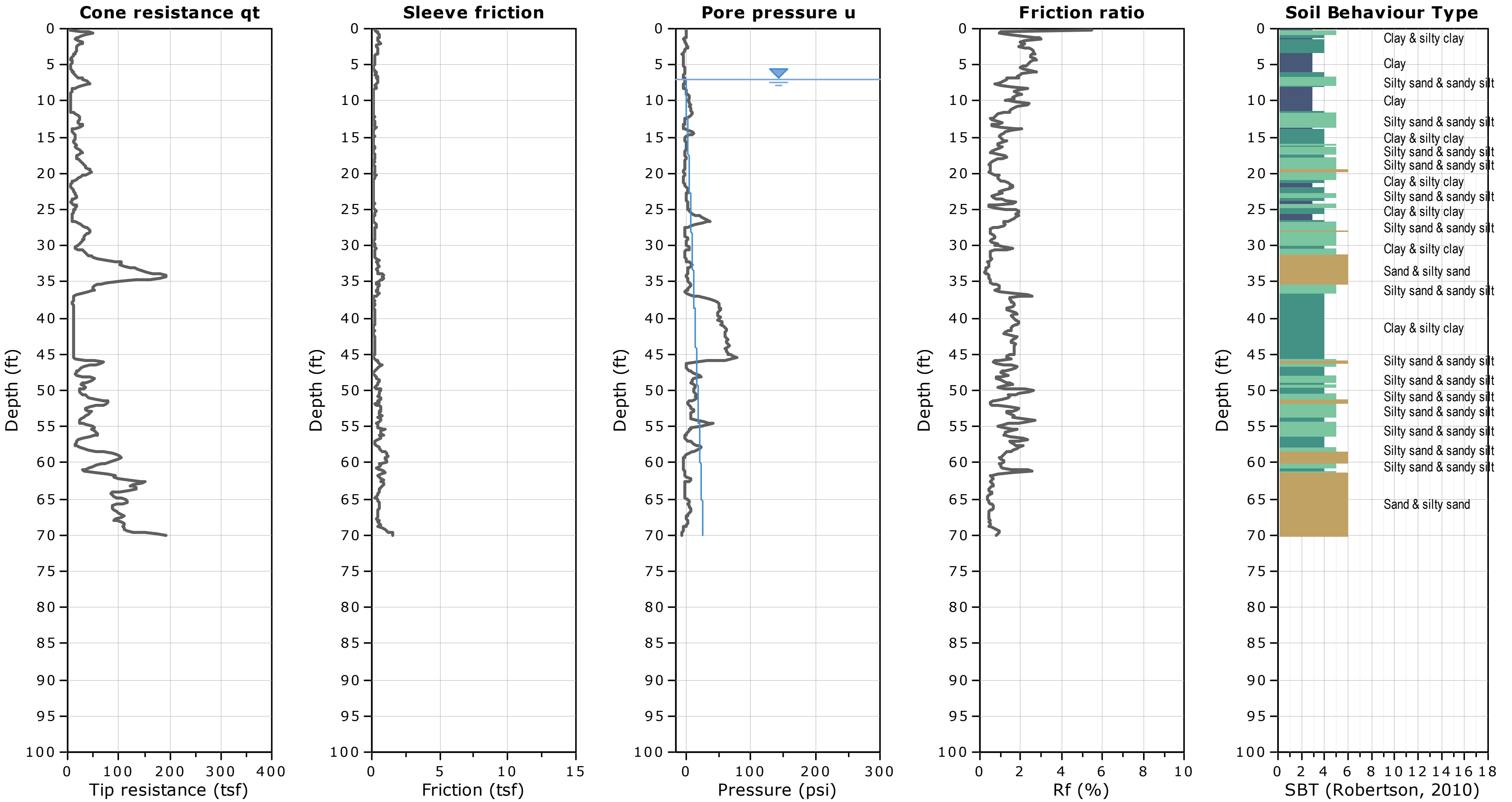


GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: CPT-01

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 70.05 ft, Date: 7/9/2020



🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty clay	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬜ 8. Very stiff sand to clayey
🟦 3. Clay to silty clay	🟨 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

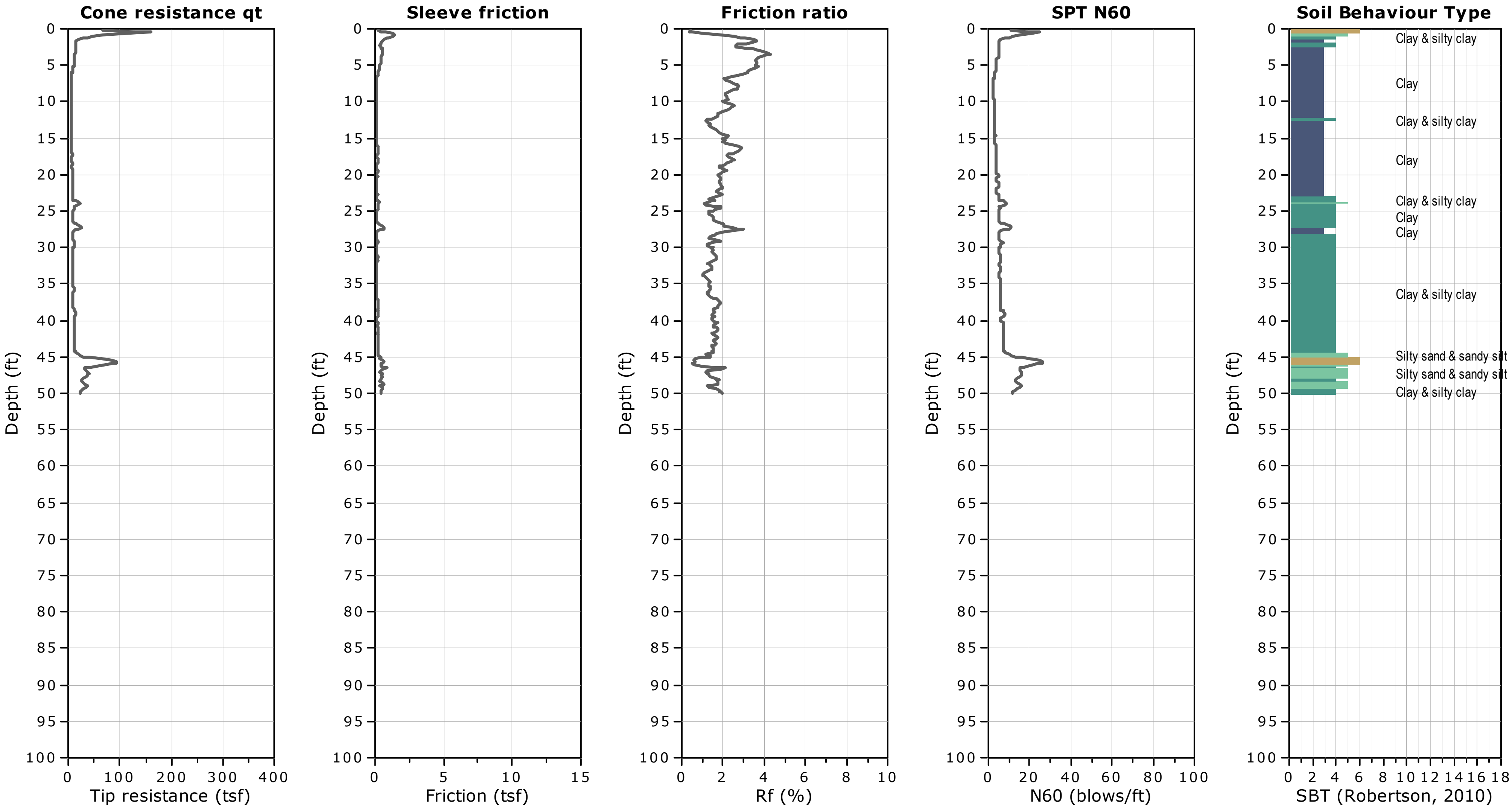
CPT: CPT-02

CLIENT: CORNERSTONE

SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN

Total depth: 50.03 ft, Date: 7/10/2020



🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey
⬜ 9. Very stiff fine grained

GREGG DRILLING, LLC
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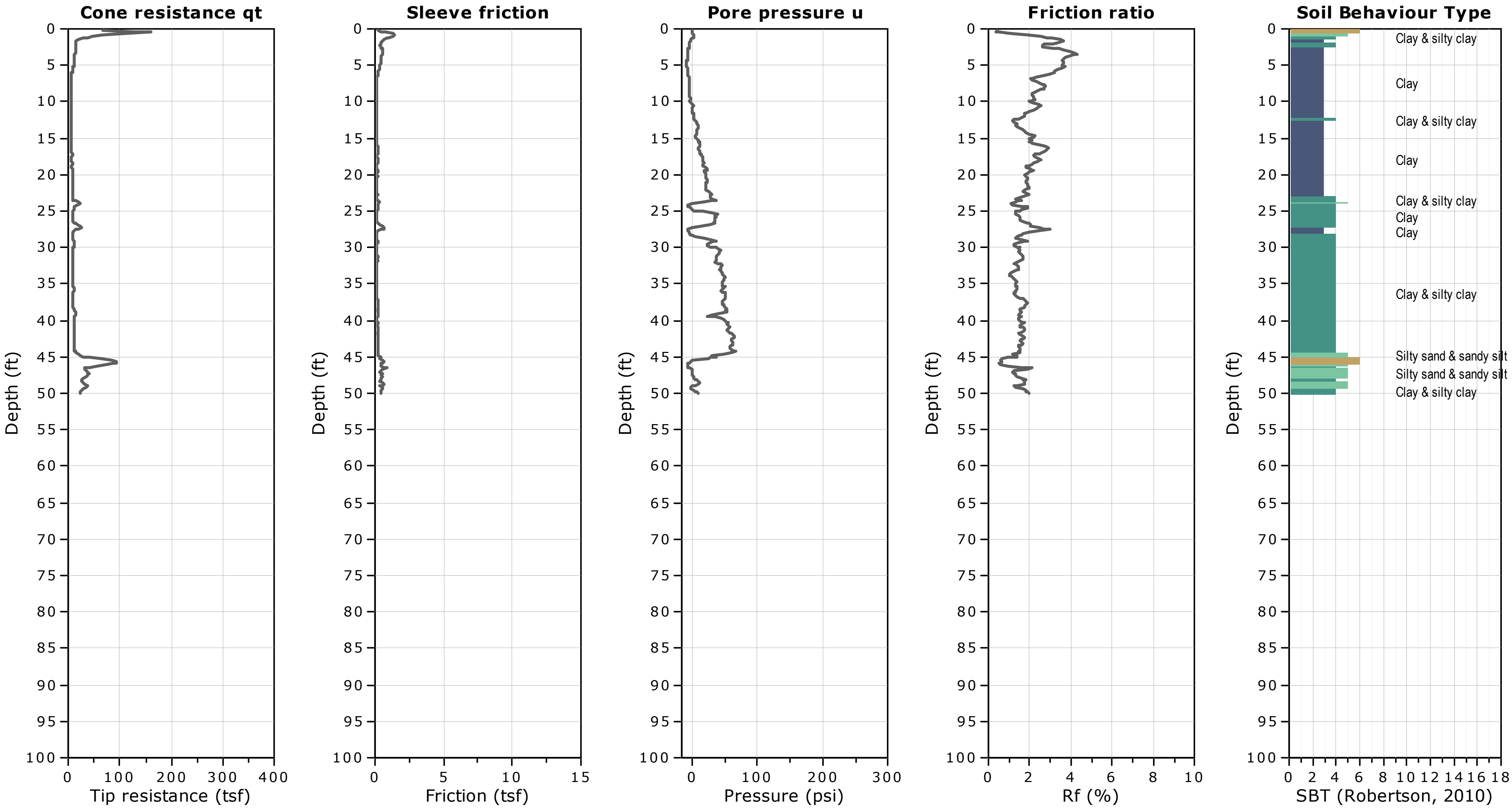
CPT: CPT-02

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 50.03 ft, Date: 7/10/2020



🟥 1. Sensitive fine grained
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🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬜ 8. Very stiff sand to clayey
⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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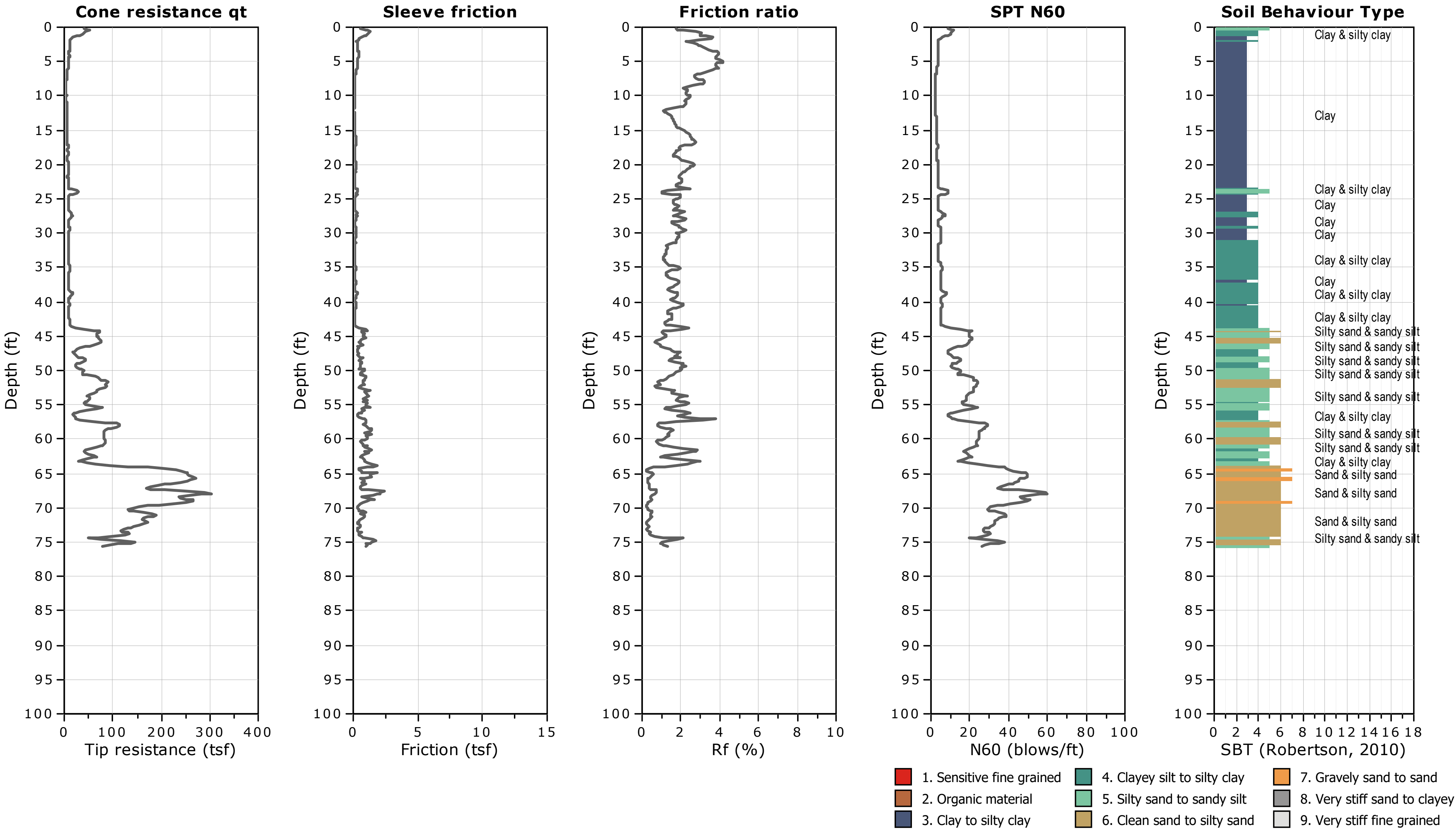
CPT: CPT-03

CLIENT: CORNERSTONE

SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN

Total depth: 75.62 ft, Date: 7/10/2020

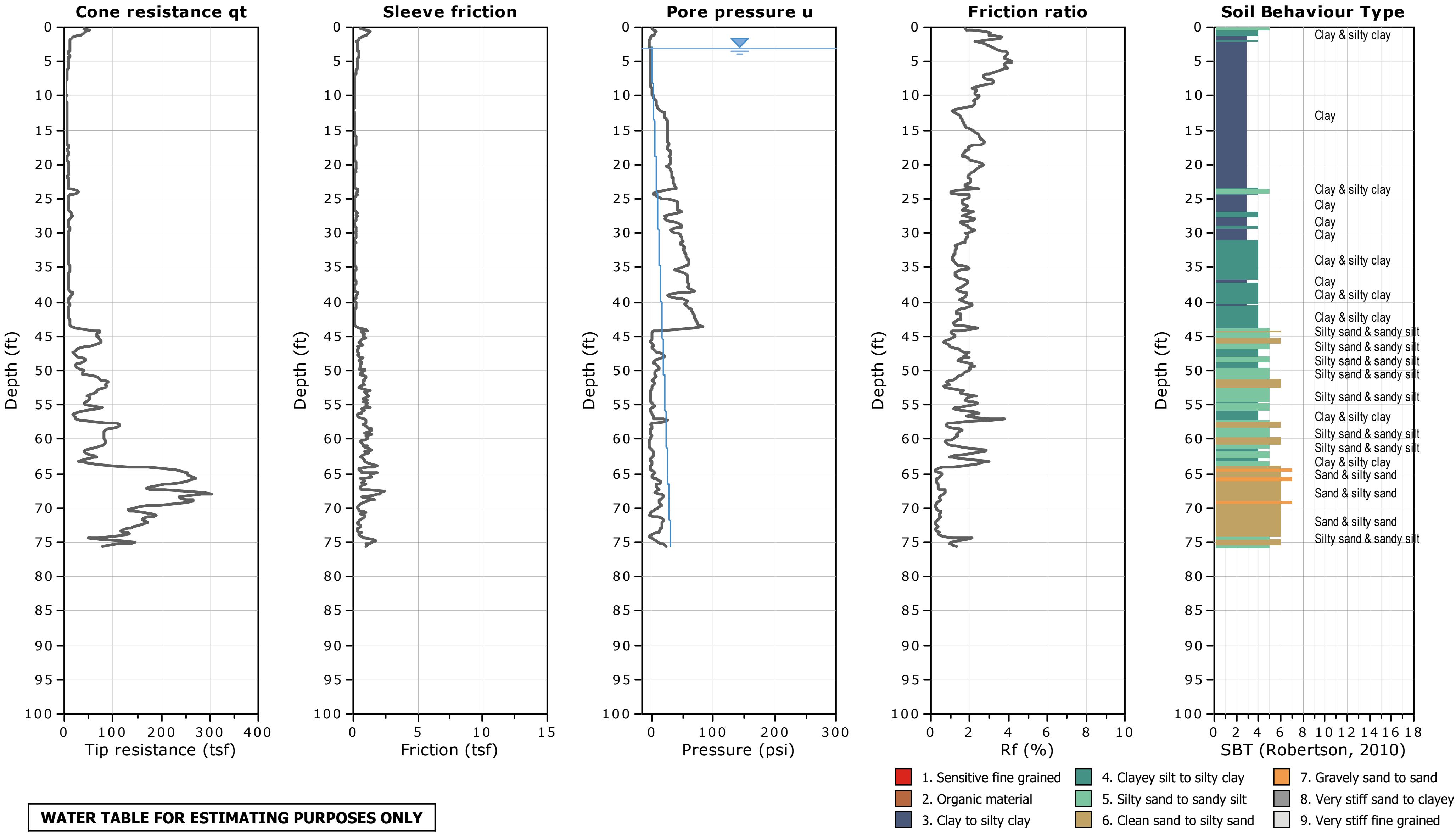


GREGG DRILLING, LLC
WWW.GREGGDRILLING.COM

CPT: CPT-03

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 75.62 ft, Date: 7/10/2020



WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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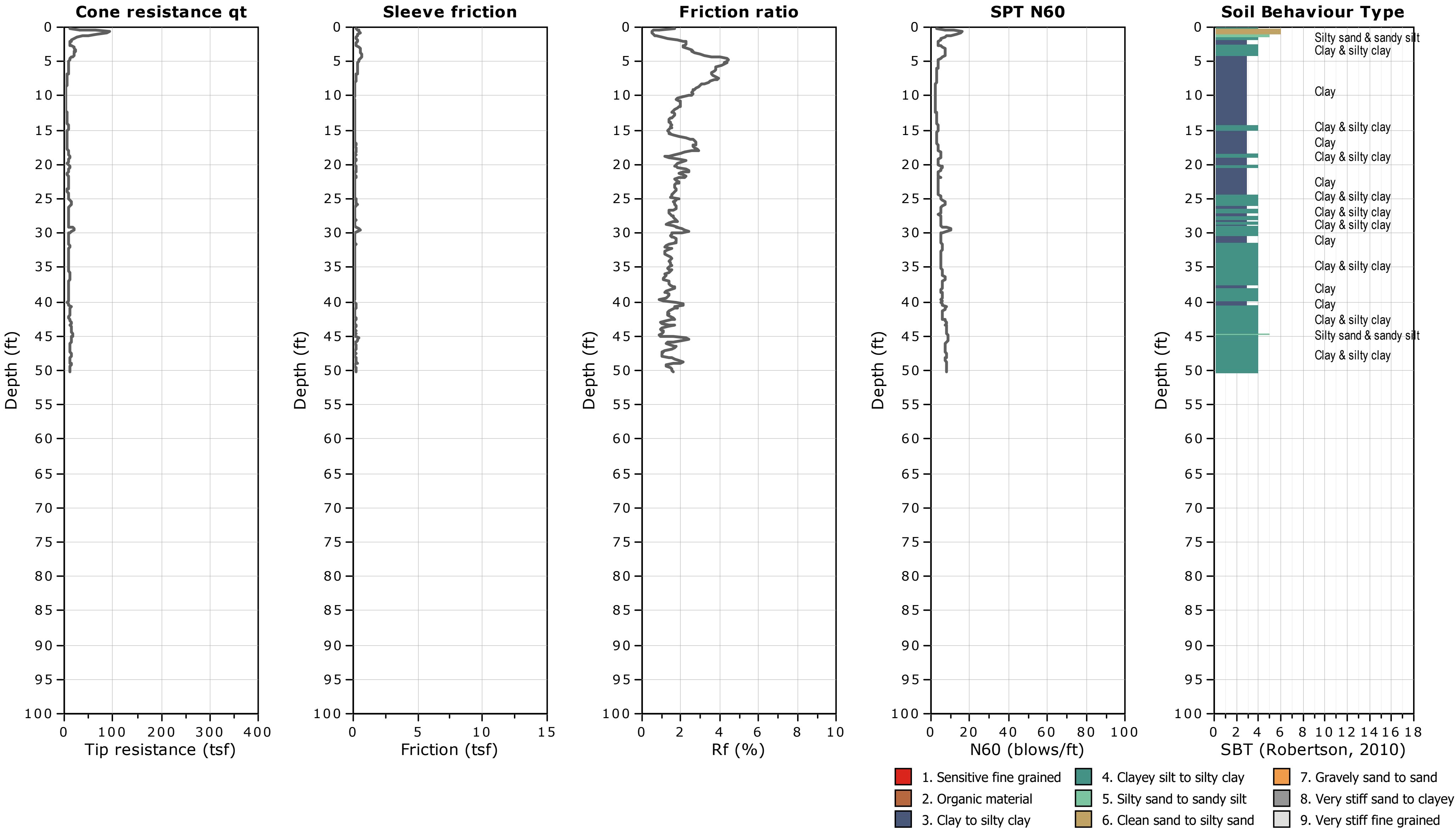
CPT: CPT-04

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

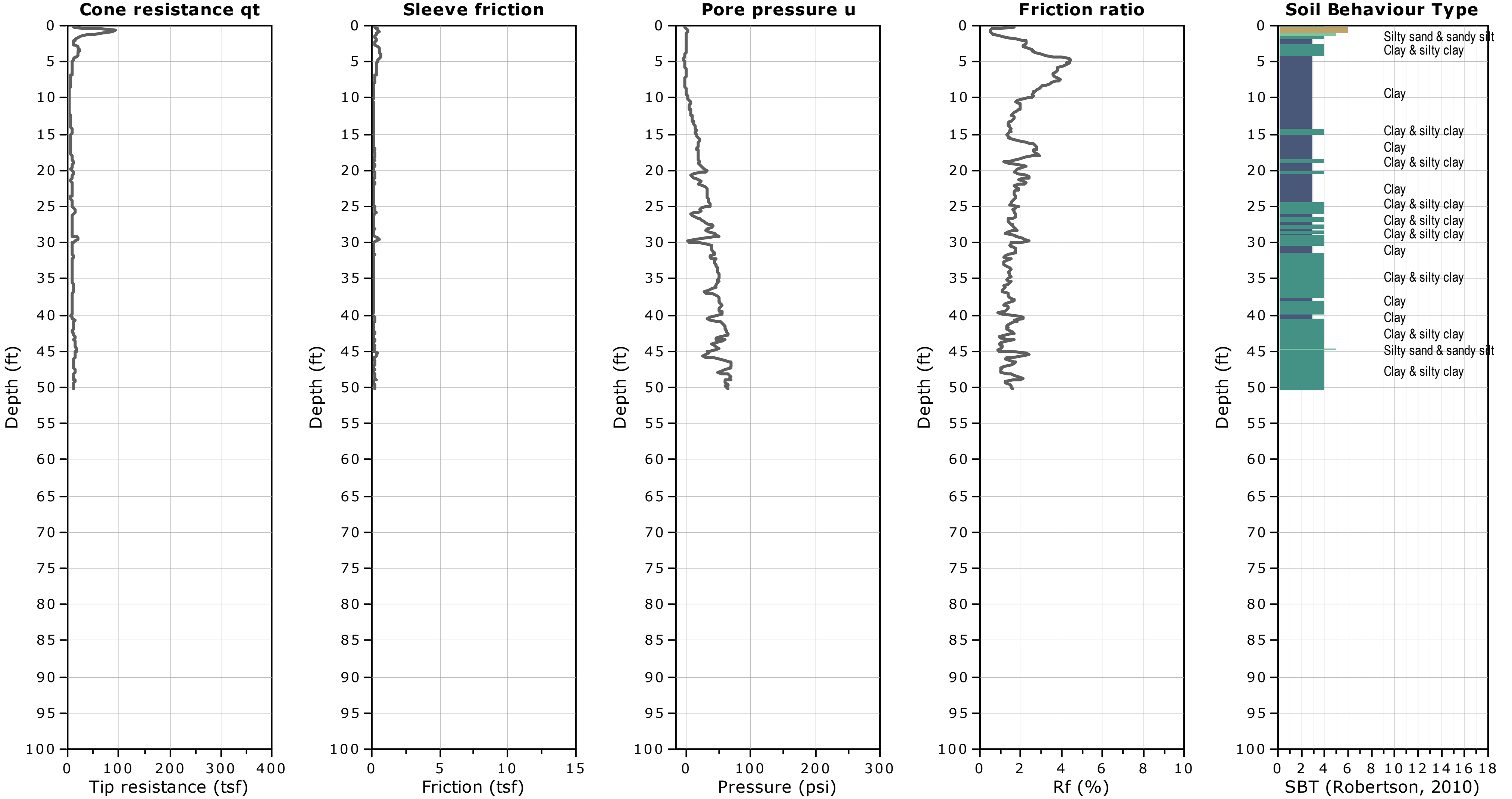
FIELD REP: DIANA LIN
Total depth: 50.20 ft, Date: 7/9/2020



CPT: CPT-04

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 50.20 ft, Date: 7/9/2020



- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty clay
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to clayey
- ⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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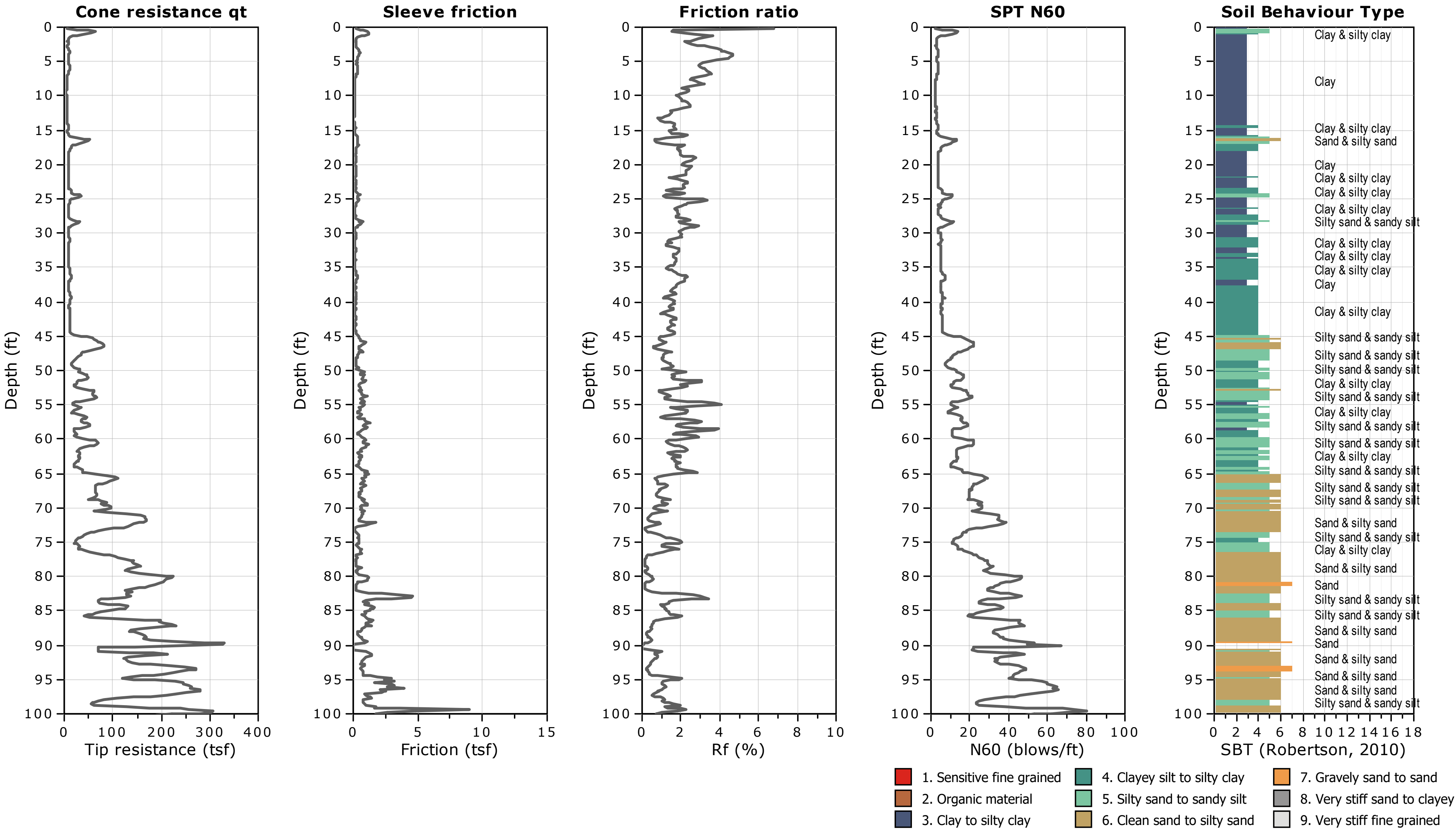
CPT: CPT-05

CLIENT: CORNERSTONE

SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN

Total depth: 100.23 ft, Date: 7/9/2020



GREGG DRILLING, LLC
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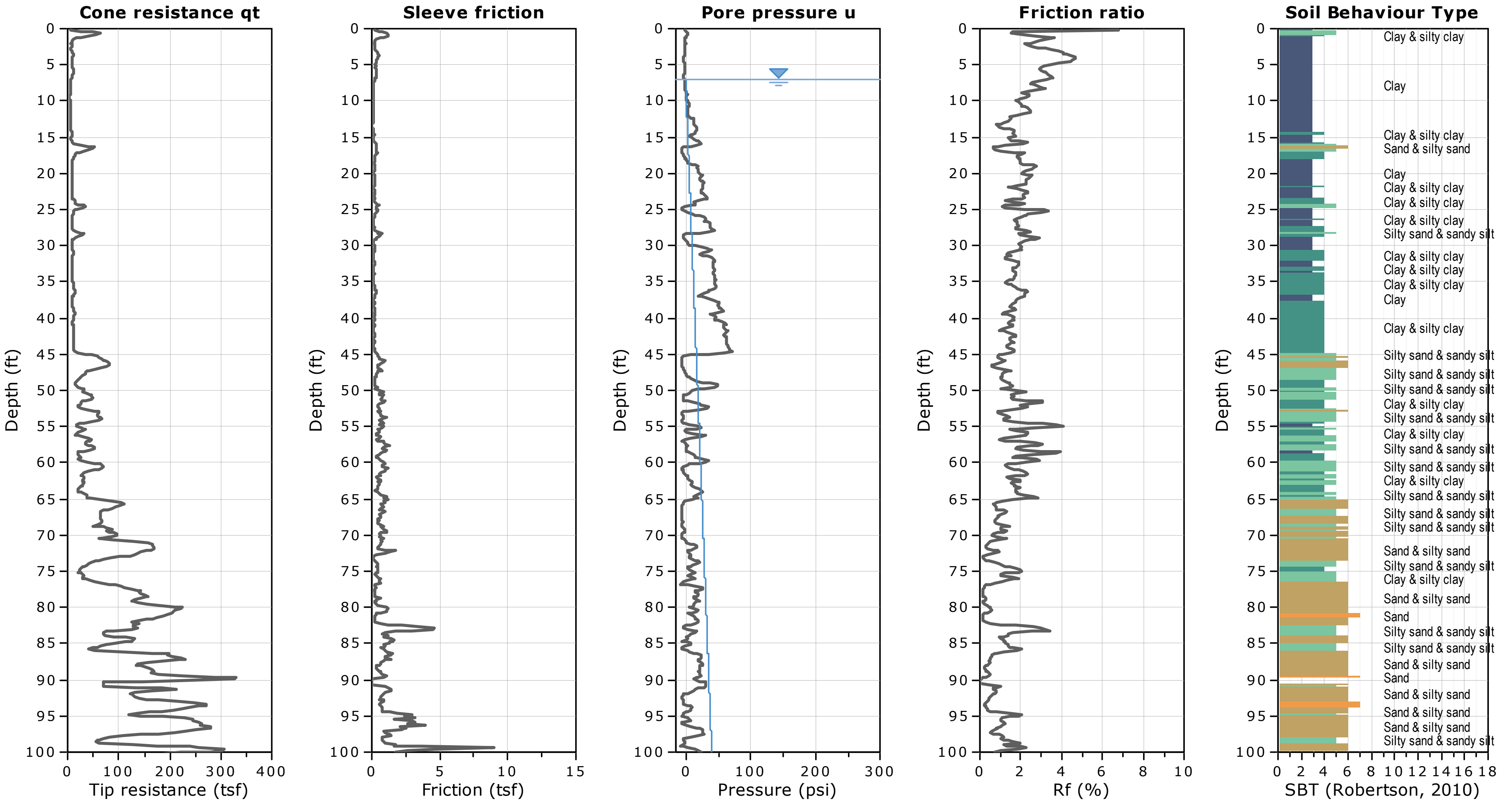
CPT: CPT-05

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 100.23 ft, Date: 7/9/2020



🟥 1. Sensitive fine grained
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🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey
⬜ 9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, LLC
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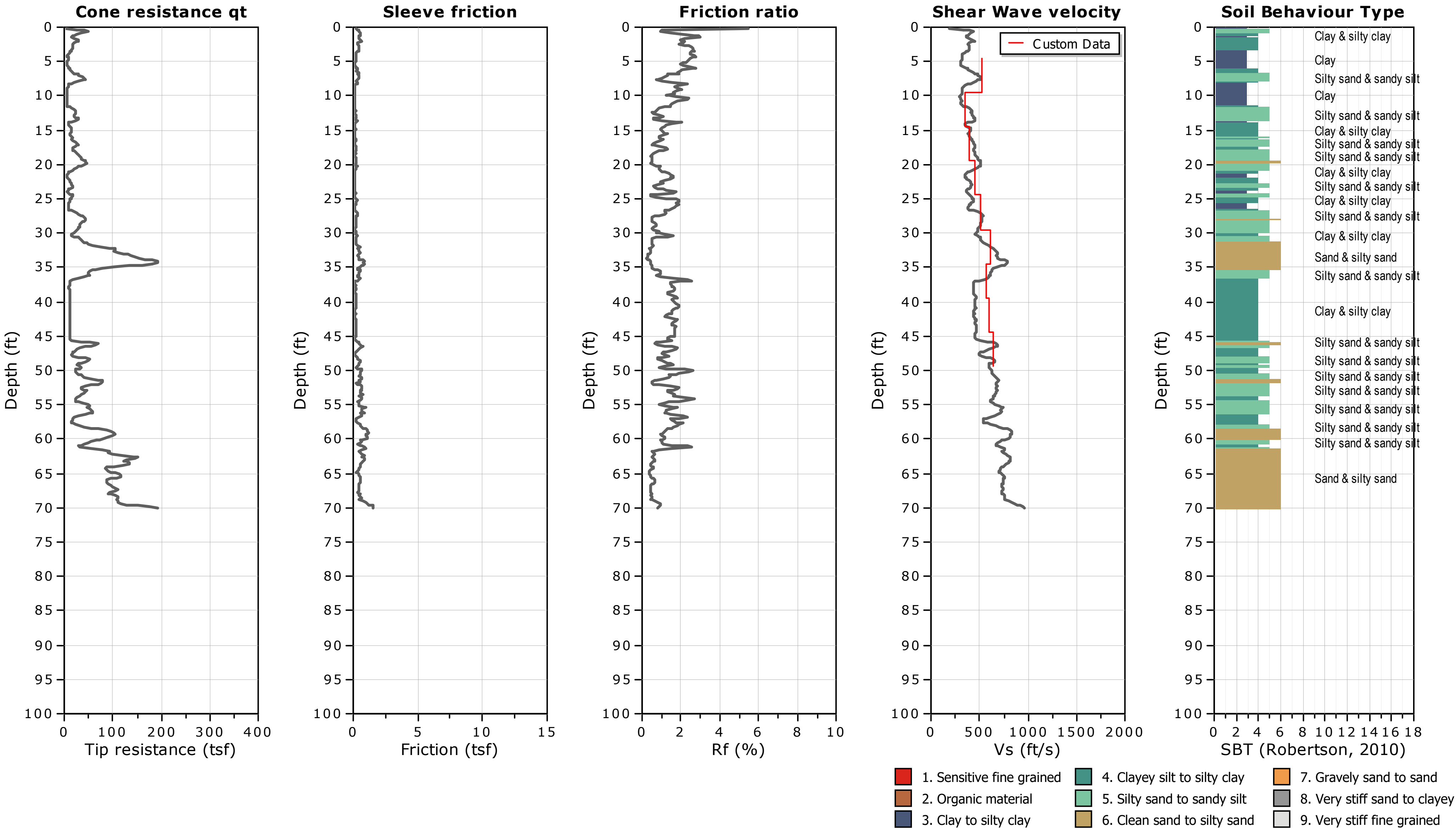
CPT: CPT-01

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 70.05 ft, Date: 7/9/2020



GREGG DRILLING, LLC
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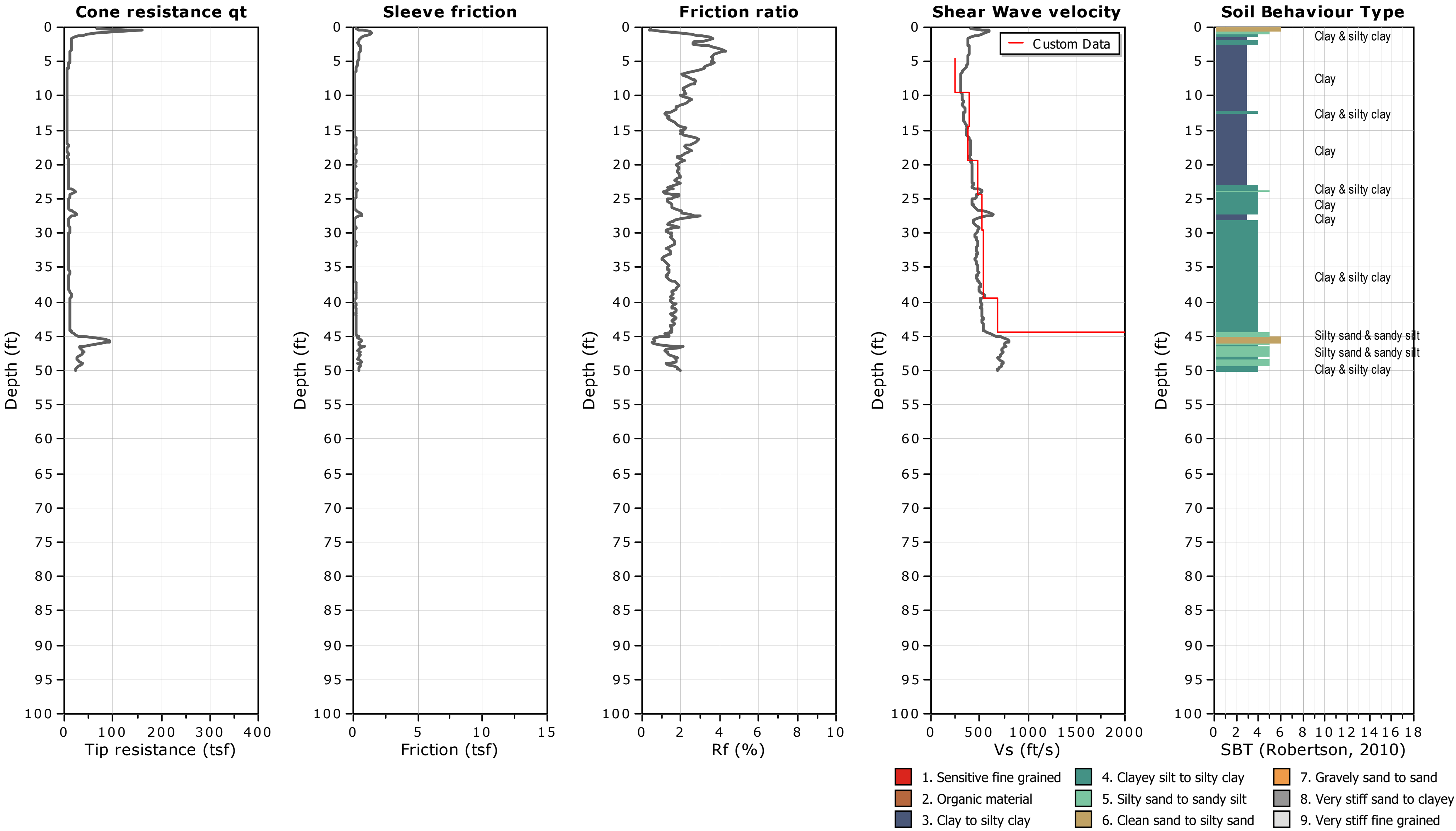
CPT: CPT-02

CLIENT: CORNERSTONE

SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN

Total depth: 50.03 ft, Date: 7/10/2020



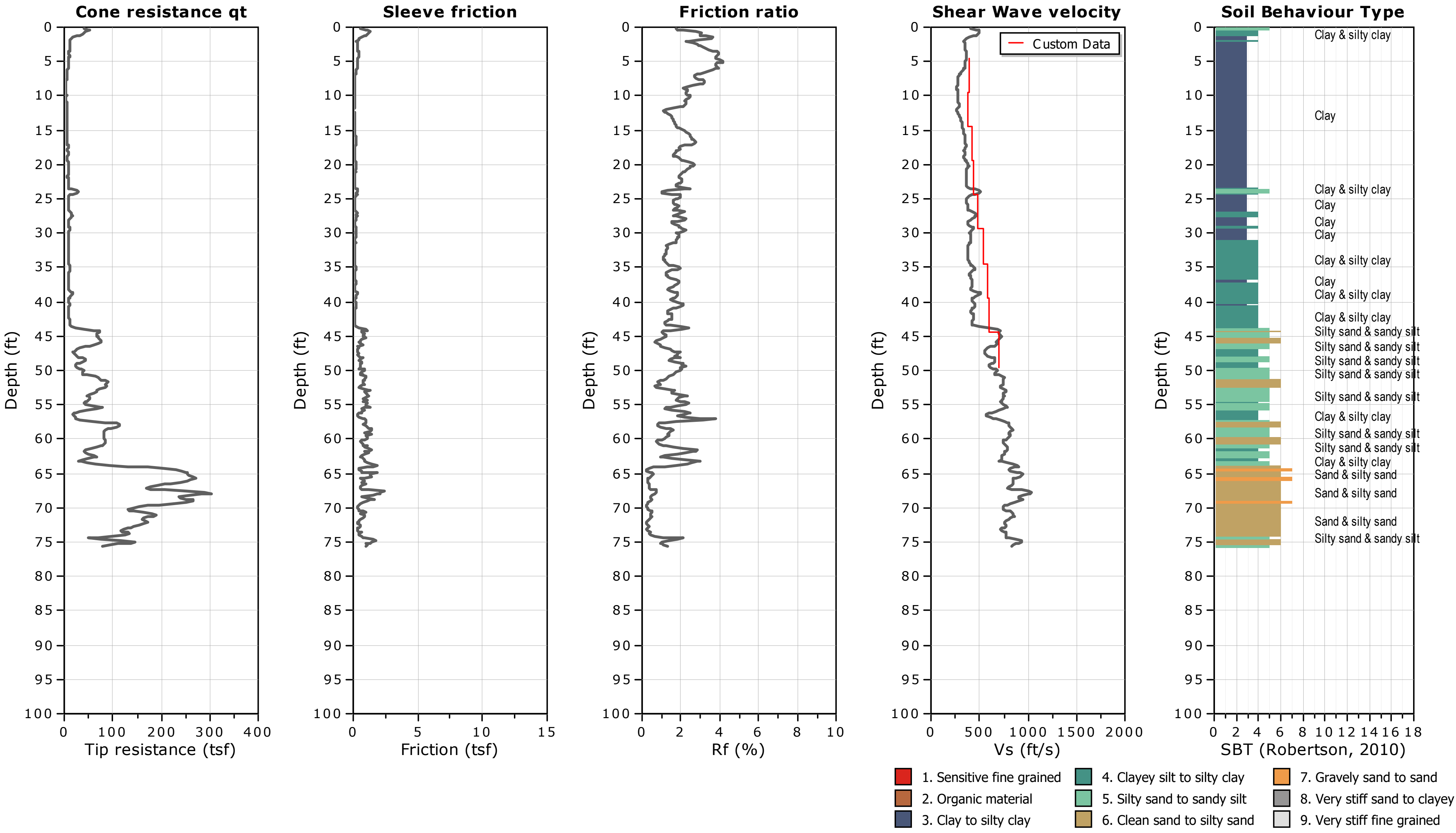
CPT: CPT-03

CLIENT: CORNERSTONE

SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN

Total depth: 75.62 ft, Date: 7/10/2020



GREGG DRILLING, LLC
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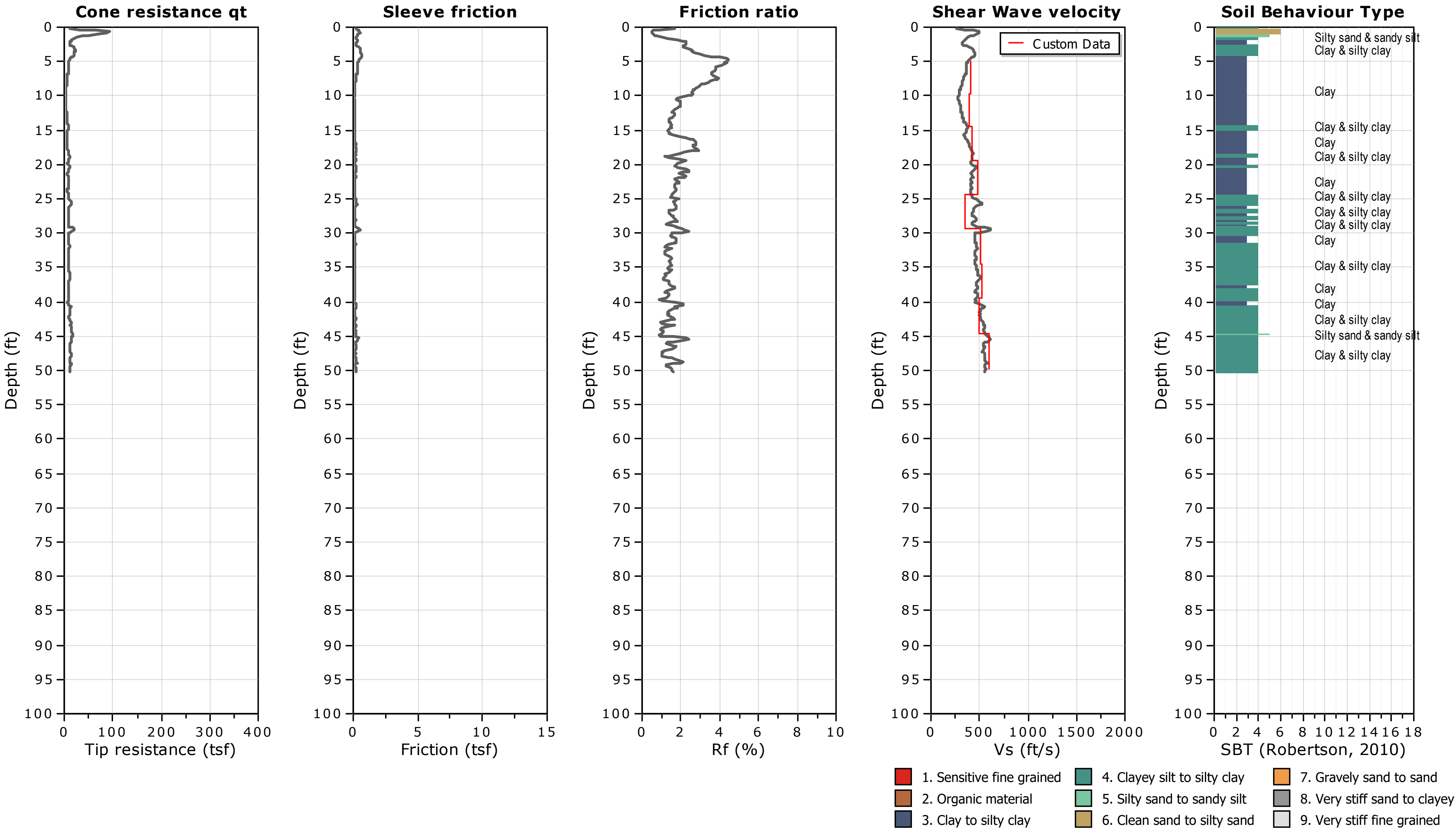
CPT: CPT-04

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 50.20 ft, Date: 7/9/2020



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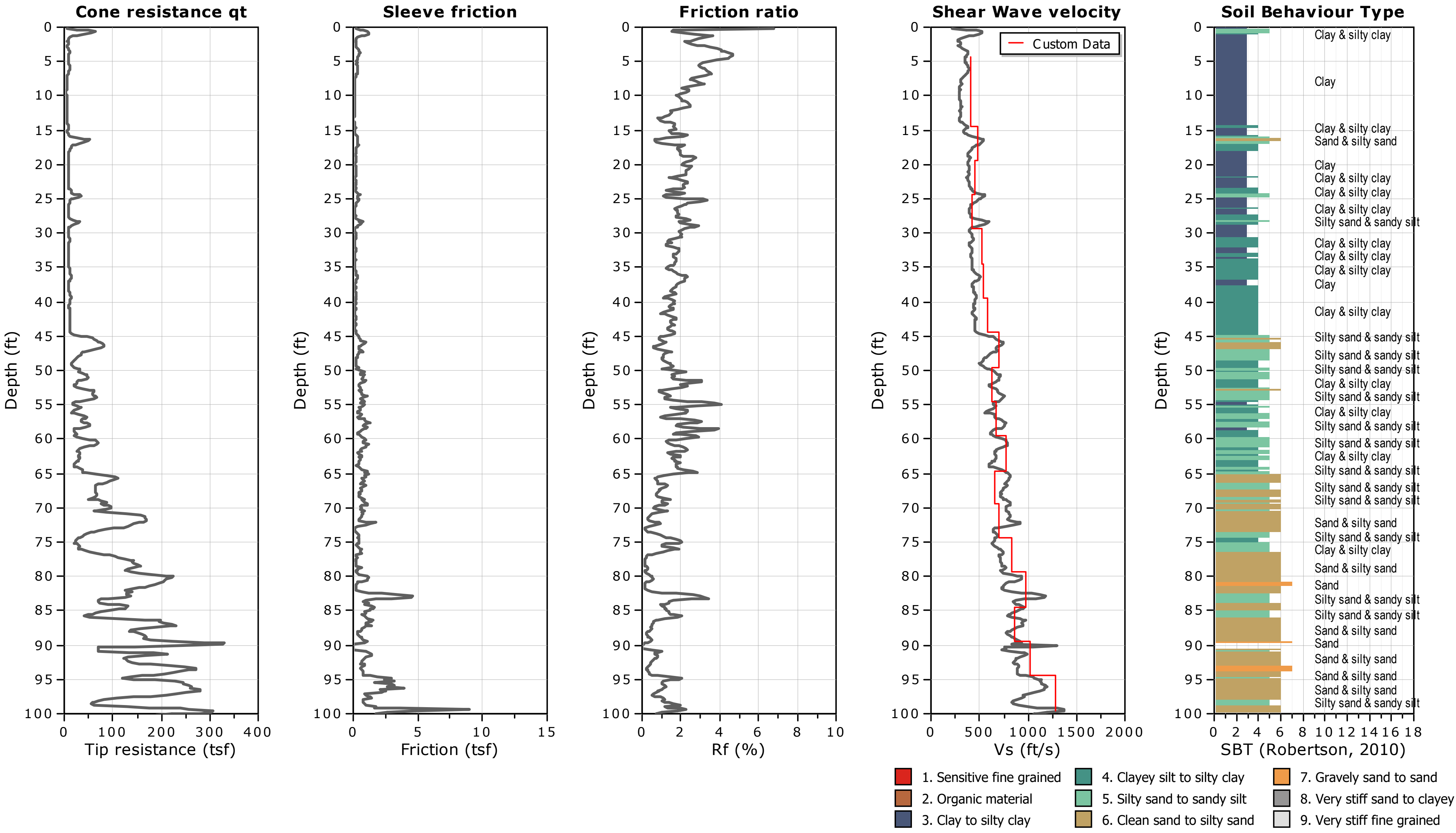
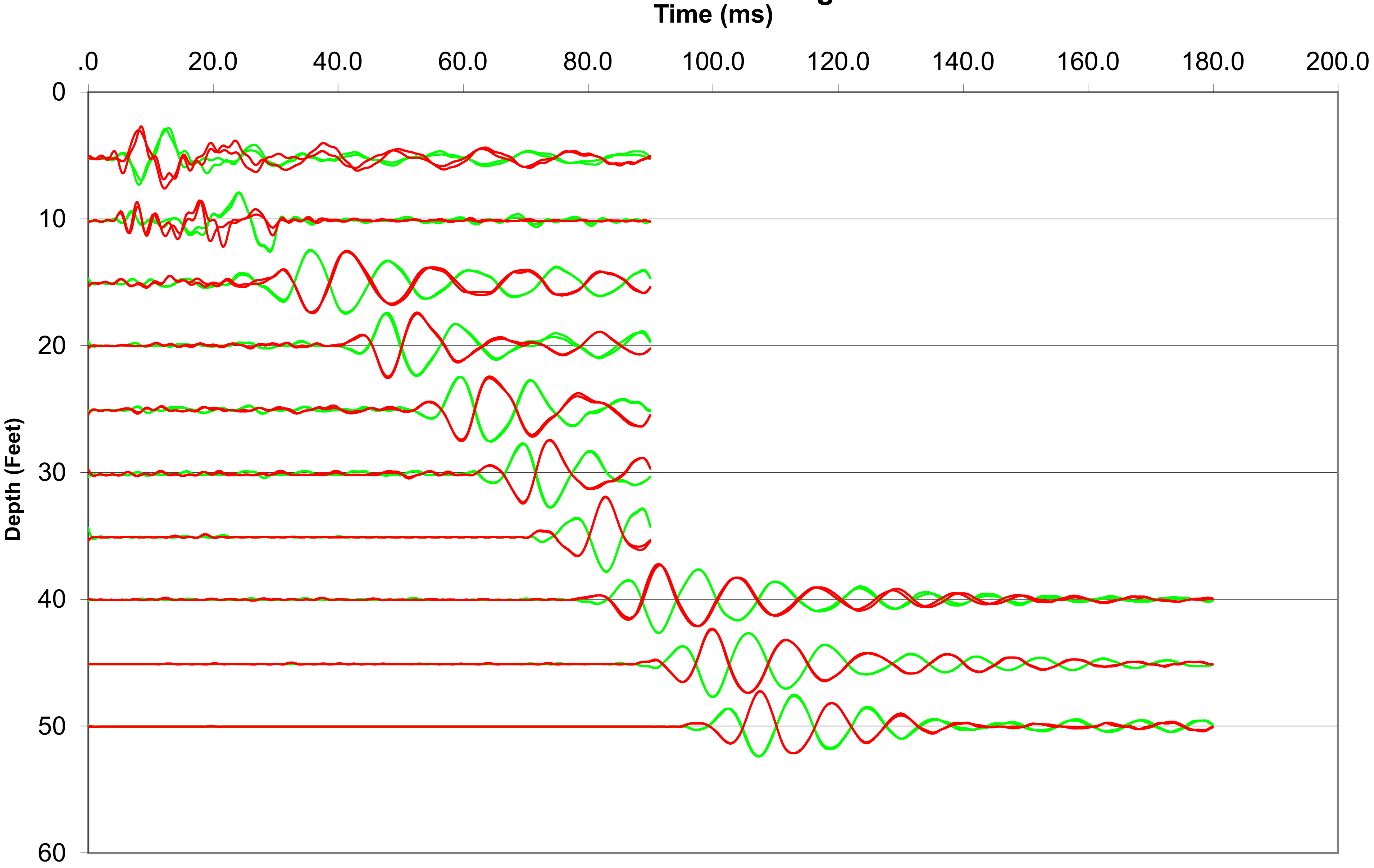
CPT: CPT-05

CLIENT: CORNERSTONE
SITE: 130 CENTER ST, CANTA CRUZ

FIELD REP: DIANA LIN
Total depth: 100.23 ft, Date: 7/9/2020



Waveforms for Sounding CPT-01



Shear Wave Velocity Calculations

130 CENTER

CPT-01

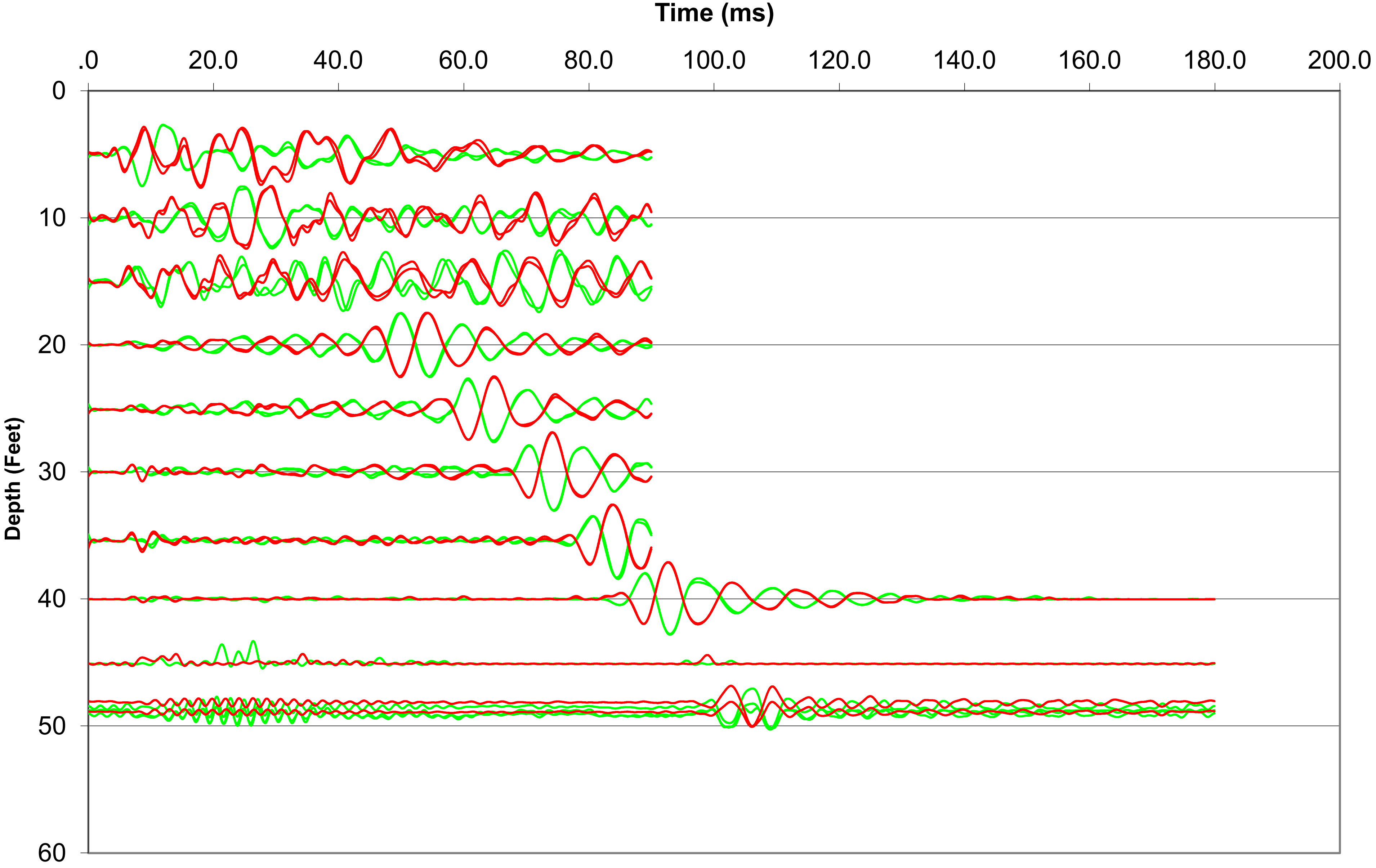
Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

07/09/20

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.25	4.59	4.88	4.88	10.3000			
10.17	9.51	9.66	4.77	19.3000	9.0000	530.3	7.05
15.09	14.43	14.53	4.87	33.0000	13.7000	355.6	11.97
20.01	19.35	19.42	4.90	45.2000	12.2000	401.4	16.89
25.10	24.44	24.50	5.07	56.5500	11.3500	446.7	21.90
30.18	29.52	29.57	5.08	66.5000	9.9500	510.1	26.98
35.10	34.44	34.49	4.91	74.5000	8.0000	614.3	31.98
40.03	39.37	39.40	4.92	83.2000	8.7000	565.1	36.91
45.11	44.45	44.48	5.08	91.7000	8.5000	597.8	41.91
50.03	49.37	49.40	4.92	99.4000	7.7000	638.7	46.91

Top Layer (feet)	Bottom Layer (feet)	Layer Velocity (ft/s)
4.6	9.5	530.3
9.5	14.4	355.6
14.4	19.4	401.4
19.4	24.4	446.7
24.4	29.5	510.1
29.5	34.4	614.3
34.4	39.4	565.1
39.4	44.5	597.8
44.5	49.4	638.7

Waveforms for Sounding CPT-02



Shear Wave Velocity Calculations

130 CENTER

CPT-02

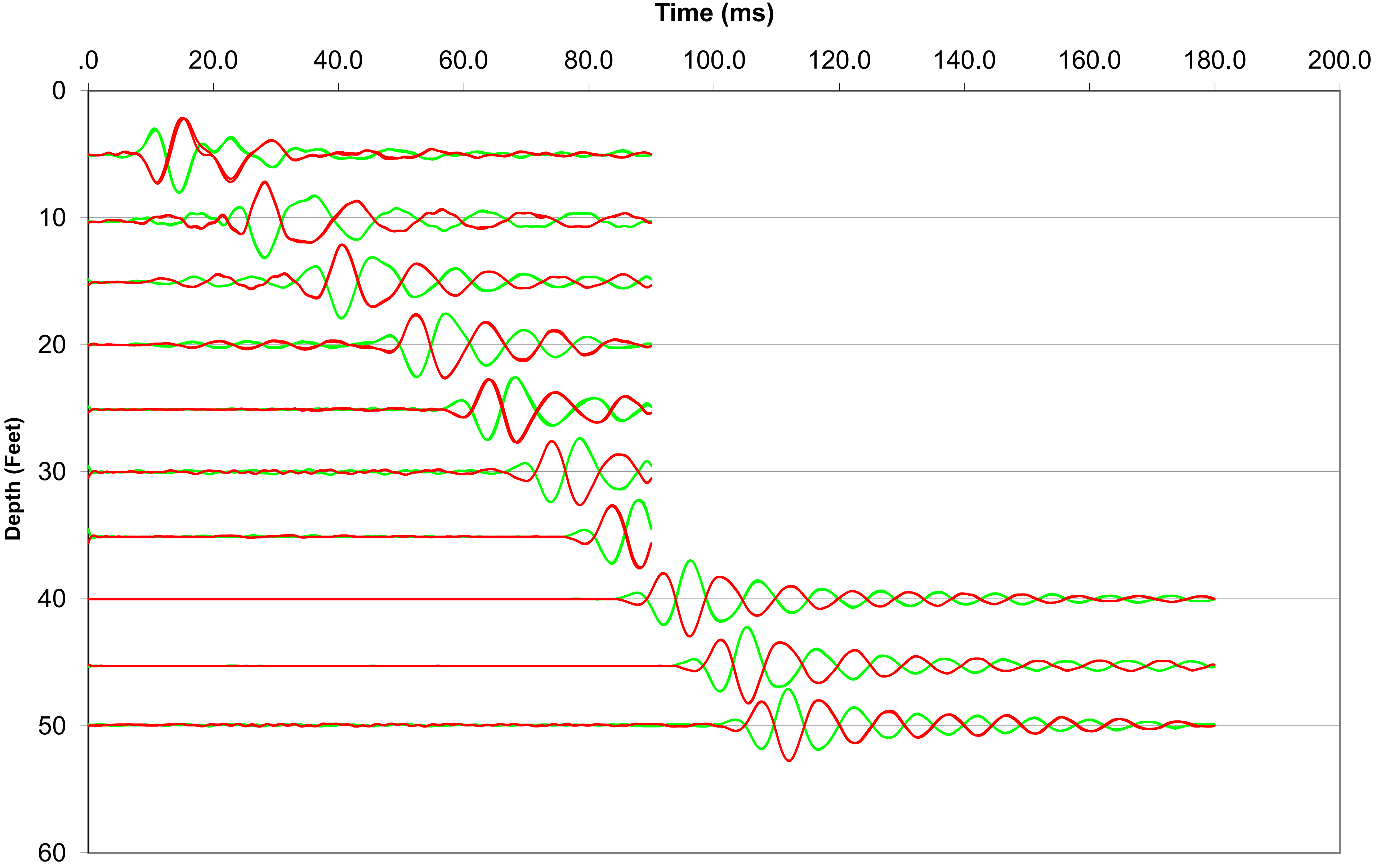
Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

07/10/20

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	4.73	4.73	6.8000			
10.17	9.51	9.66	4.93	26.9000	20.1000	245.1	6.97
15.09	14.43	14.53	4.87	39.4500	12.5500	388.2	11.97
20.01	19.35	19.42	4.90	52.2000	12.7500	384.1	16.89
25.10	24.44	24.50	5.07	62.7500	10.5500	480.6	21.90
30.02	29.36	29.41	4.91	72.1000	9.3500	525.3	26.90
35.43	34.77	34.81	5.41	82.1000	10.0000	540.6	32.07
40.03	39.37	39.40	4.59	90.5500	8.4500	543.0	37.07
45.11	44.45	44.48	5.08	97.9000	7.3500	691.3	41.91
50.03	49.37	49.40	4.92	99.9000	2.0000	2459.1	46.91

Top Layer (feet)	Bottom Layer (feet)	Layer Velocity (ft/s)
4.4	9.5	245.1
9.5	14.4	388.2
14.4	19.4	384.1
19.4	24.4	480.6
24.4	29.4	525.3
29.4	34.8	540.6
34.8	39.4	543.0
39.4	44.5	691.3
44.5	49.4	2459.1

Waveforms for Sounding CPT-03



Shear Wave Velocity Calculations

130 CENTER

CPT-03

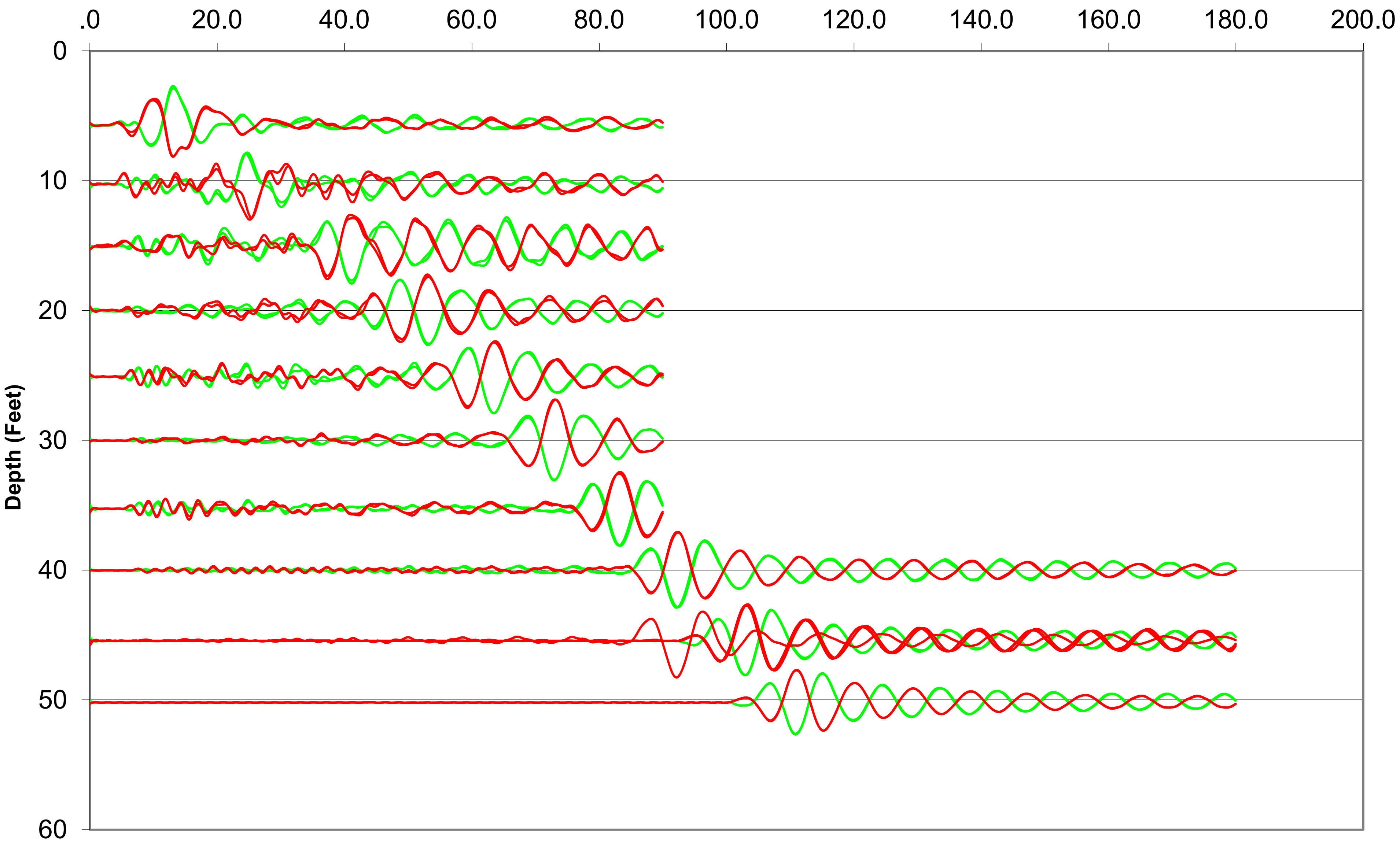
Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

07/10/20

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	4.73	4.73	12.6500			
10.33	9.67	9.82	5.09	25.5000	12.8500	395.9	7.05
15.09	14.43	14.53	4.71	37.9500	12.4500	378.3	12.05
20.01	19.35	19.42	4.90	49.5500	11.6000	422.1	16.89
25.10	24.44	24.50	5.07	61.3000	11.7500	431.5	21.90
30.02	29.36	29.41	4.91	71.3500	10.0500	488.7	26.90
35.10	34.44	34.49	5.08	80.8500	9.5000	534.6	31.90
40.03	39.37	39.40	4.92	89.3000	8.4500	581.8	36.91
45.28	44.62	44.65	5.25	98.1500	8.8500	592.7	41.99
50.03	49.37	49.40	4.75	105.0000	6.8500	694.0	46.99

Top Layer (feet)	Bottom Layer (feet)	Layer Velocity (ft/s)
4.4	9.7	395.9
9.7	14.4	378.3
14.4	19.4	422.1
19.4	24.4	431.5
24.4	29.4	488.7
29.4	34.4	534.6
34.4	39.4	581.8
39.4	44.6	592.7
44.6	49.4	694.0

Waveforms for Sounding CPT-04



Shear Wave Velocity Calculations

130 CENTER

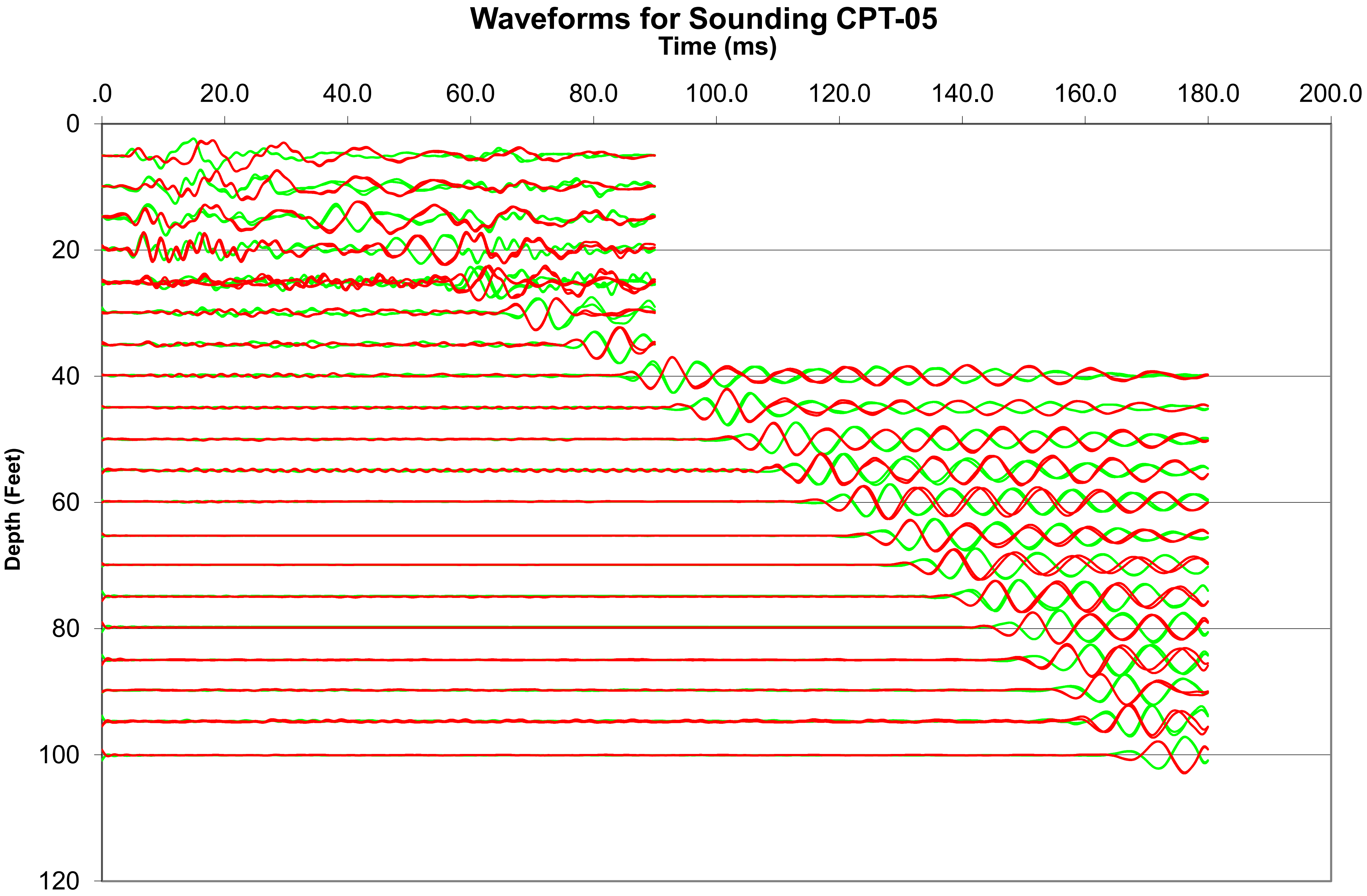
CPT-04

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

07/09/20

Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.74	5.08	5.35	5.35	11.5500			
10.33	9.67	9.82	4.47	22.6500	11.1000	402.6	7.38
15.09	14.43	14.53	4.71	34.7500	12.1000	389.3	12.05
20.01	19.35	19.42	4.90	46.4500	11.7000	418.5	16.89
25.10	24.44	24.50	5.07	56.9000	10.4500	485.2	21.90
30.02	29.36	29.41	4.91	70.7500	13.8500	354.6	26.90
35.27	34.61	34.65	5.24	80.9500	10.2000	513.9	31.98
40.03	39.37	39.40	4.75	90.0500	9.1000	522.2	36.99
45.44	44.78	44.81	5.41	100.8000	10.7500	503.2	42.07
50.20	49.54	49.56	4.75	108.7500	7.9500	598.0	47.16

Top Layer (feet)	Bottom Layer (feet)	Layer Velocity (ft/s)
5.1	9.7	402.6
9.7	14.4	389.3
14.4	19.4	418.5
19.4	24.4	485.2
24.4	29.4	354.6
29.4	34.6	513.9
34.6	39.4	522.2
39.4	44.8	503.2
44.8	49.5	598.0


Waveforms for Sounding CPT-05
Time (ms)
.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
0
20
40
60
80
100
120
Depth (Feet)

Shear Wave Velocity Calculations

130 CENTER

CPT-05

Geophone Offset: 0.66 Feet
Source Offset: 1.67 Feet

07/09/20

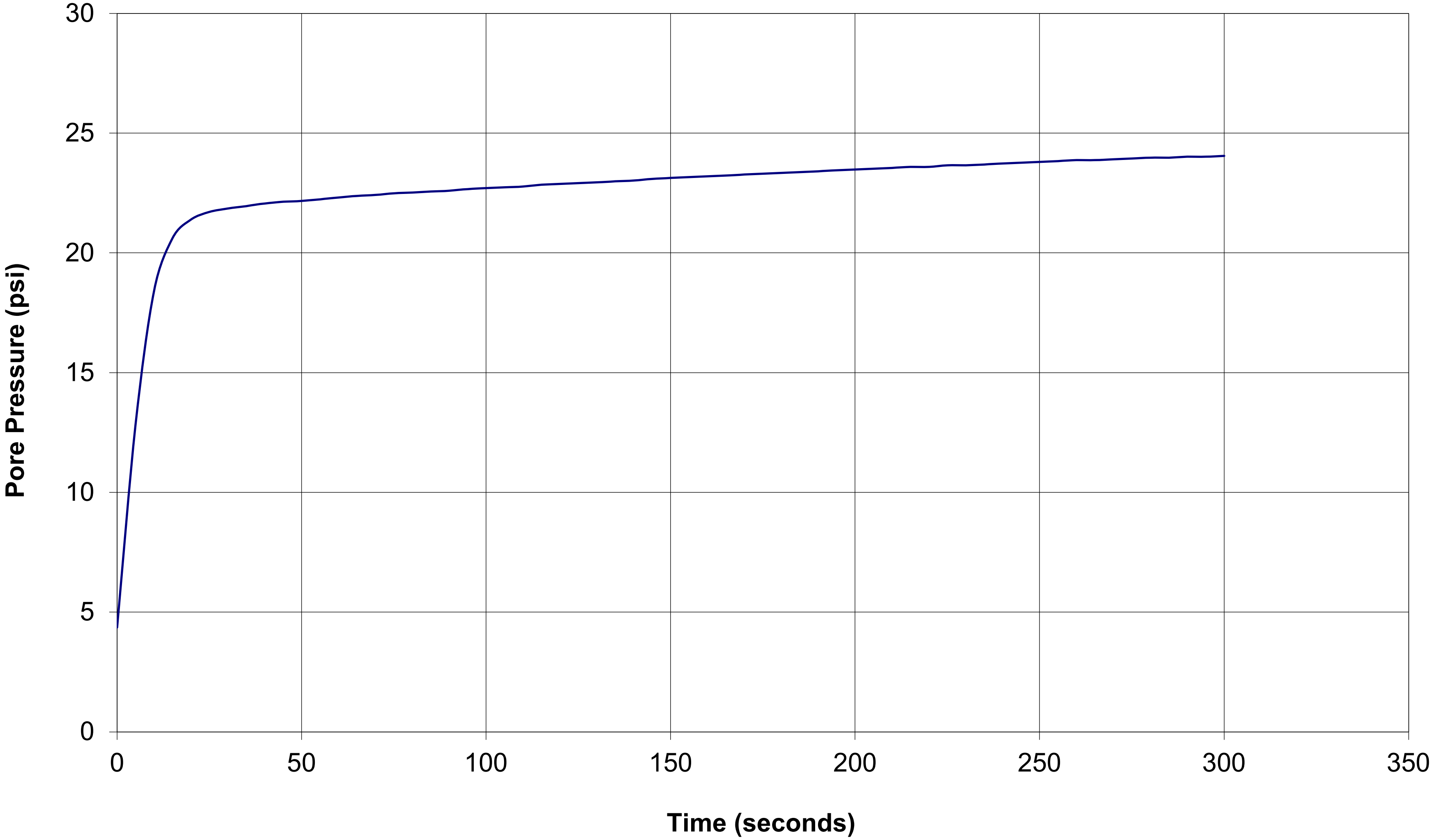
Test Depth (Feet)	Geophone Depth (Feet)	Waveform Ray Path (Feet)	Incremental Distance (Feet)	Characteristic Arrival Time (ms)	Incremental Time Interval (ms)	Interval Velocity (Ft/Sec)	Interval Depth (Feet)
5.09	4.43	4.73	4.73	15.5500			
10.01	9.35	9.49	4.76	27.2500	11.7000	407.2	6.89
15.09	14.43	14.53	5.03	39.6000	12.3500	407.6	11.89
20.01	19.35	19.42	4.90	49.7000	10.1000	484.8	16.89
25.26	24.60	24.66	5.23	61.4000	11.7000	447.4	21.98
30.02	29.36	29.41	4.75	72.6000	11.2000	423.9	26.98
35.10	34.44	34.49	5.08	82.2000	9.6000	529.0	31.90
40.03	39.37	39.40	4.92	91.2000	9.0000	546.2	36.91
45.11	44.45	44.48	5.08	99.8000	8.6000	590.8	41.91
50.20	49.54	49.56	5.08	107.0000	7.2000	705.8	46.99
55.12	54.46	54.48	4.92	114.7500	7.7500	634.7	52.00
60.04	59.38	59.40	4.92	122.1000	7.3500	669.3	56.92
65.45	64.79	64.81	5.41	129.0500	6.9500	778.6	62.09
70.05	69.39	69.41	4.59	136.0500	7.0000	656.0	67.09
75.13	74.47	74.49	5.08	143.2500	7.2000	706.1	71.93
80.05	79.39	79.41	4.92	149.1500	5.9000	833.9	76.93
85.14	84.48	84.49	5.08	154.3500	5.2000	977.7	81.93
90.06	89.40	89.41	4.92	160.1000	5.7500	855.7	86.94
95.14	94.48	94.50	5.08	165.1000	5.0000	1016.9	91.94
100.23	99.57	99.58	5.08	169.0500	3.9500	1287.2	97.03

Top Layer (feet)	Bottom Layer (feet)	Layer Velocity (ft/s)
4.4	9.3	407.2
9.3	14.4	407.6
14.4	19.4	484.8
19.4	24.6	447.4
24.6	29.4	423.9
29.4	34.4	529.0
34.4	39.4	546.2
39.4	44.5	590.8
44.5	49.5	705.8
49.5	54.5	634.7
54.5	59.4	669.3
59.4	64.8	778.6
64.8	69.4	656.0
69.4	74.5	706.1
74.5	79.4	833.9
79.4	84.5	977.7
84.5	89.4	855.7
89.4	94.5	1016.9
94.5	99.6	1287.2

GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

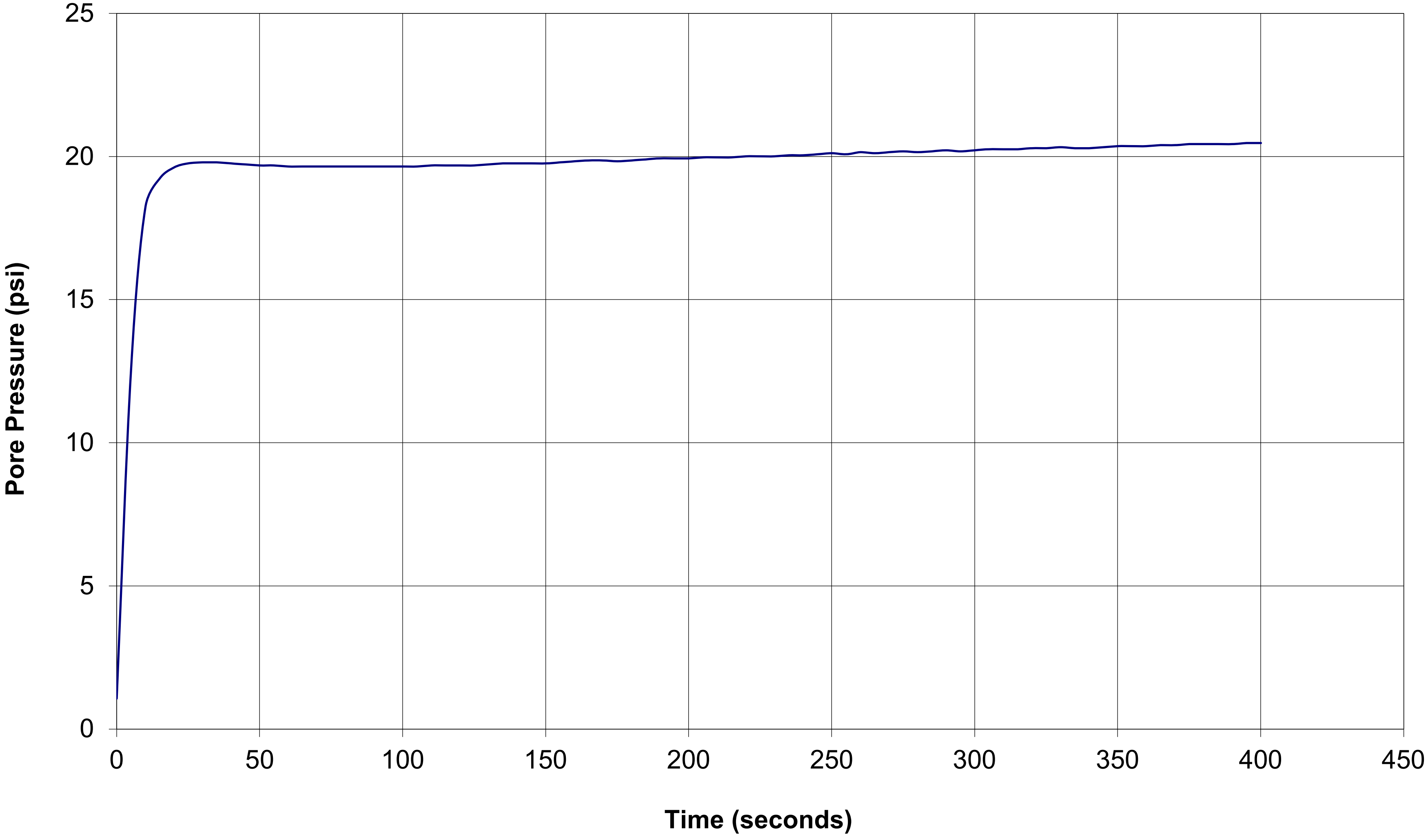
Sounding: CPT-01
Depth (ft): 62.17
Site: 130 CENTER
Engineer: DIANA LIN



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

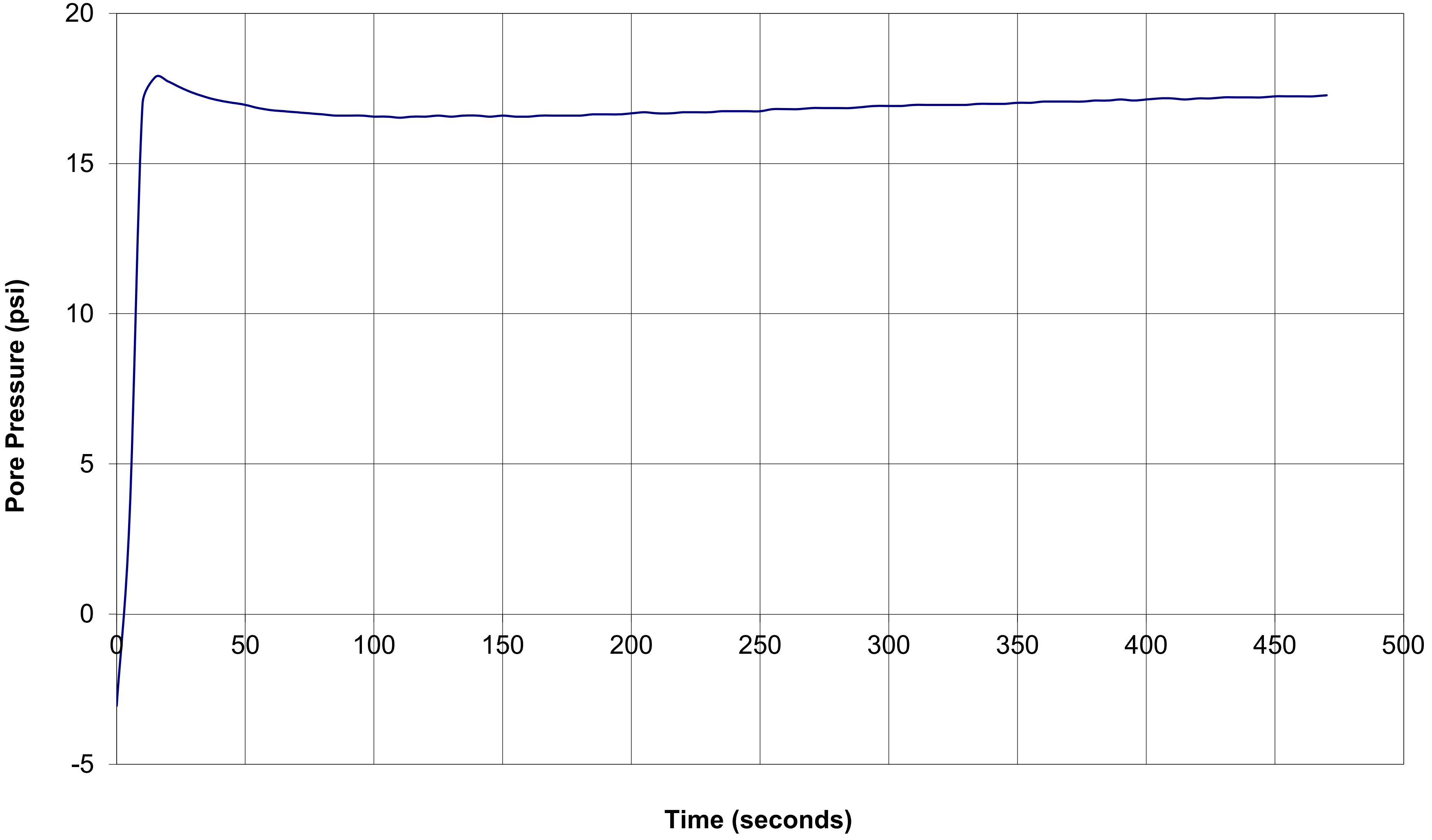
Sounding: CPT-03
Depth (ft): 46.10
Site: 130 CENTER
Engineer: DIANA LIN



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

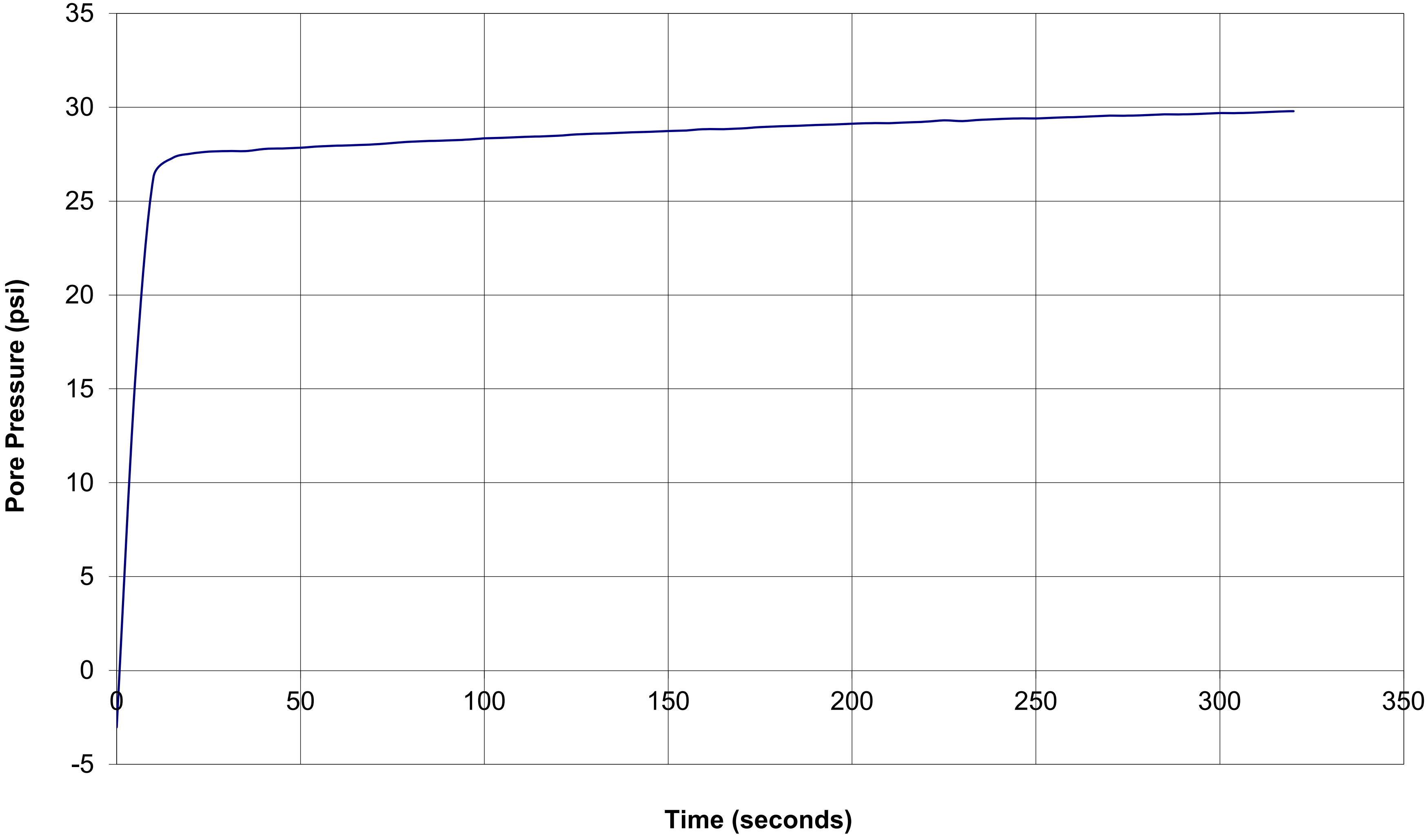
Sounding: CPT-05
Depth (ft): 46.75
Site: 130 CENTER
Engineer: DIANA LIN



GREGG DRILLING & TESTING

Pore Pressure Dissipation Test

Sounding: CPT-05
Depth (ft): 76.94
Site: 130 CENTER
Engineer: DIANA LIN



APPENDIX B: LABORATORY TEST PROGRAM

The laboratory testing program was performed to evaluate the physical and mechanical properties of the soils retrieved from the site to aid in verifying soil classification.

Moisture Content: The natural water content was determined (ASTM D2216) on 36 samples of the materials recovered from the borings. These water contents are recorded on the boring logs at the appropriate sample depths.

Dry Densities: In place dry density determinations (ASTM D2937) were performed on 27 samples to measure the unit weight of the subsurface soils. Results of these tests are shown on the boring logs at the appropriate sample depths.

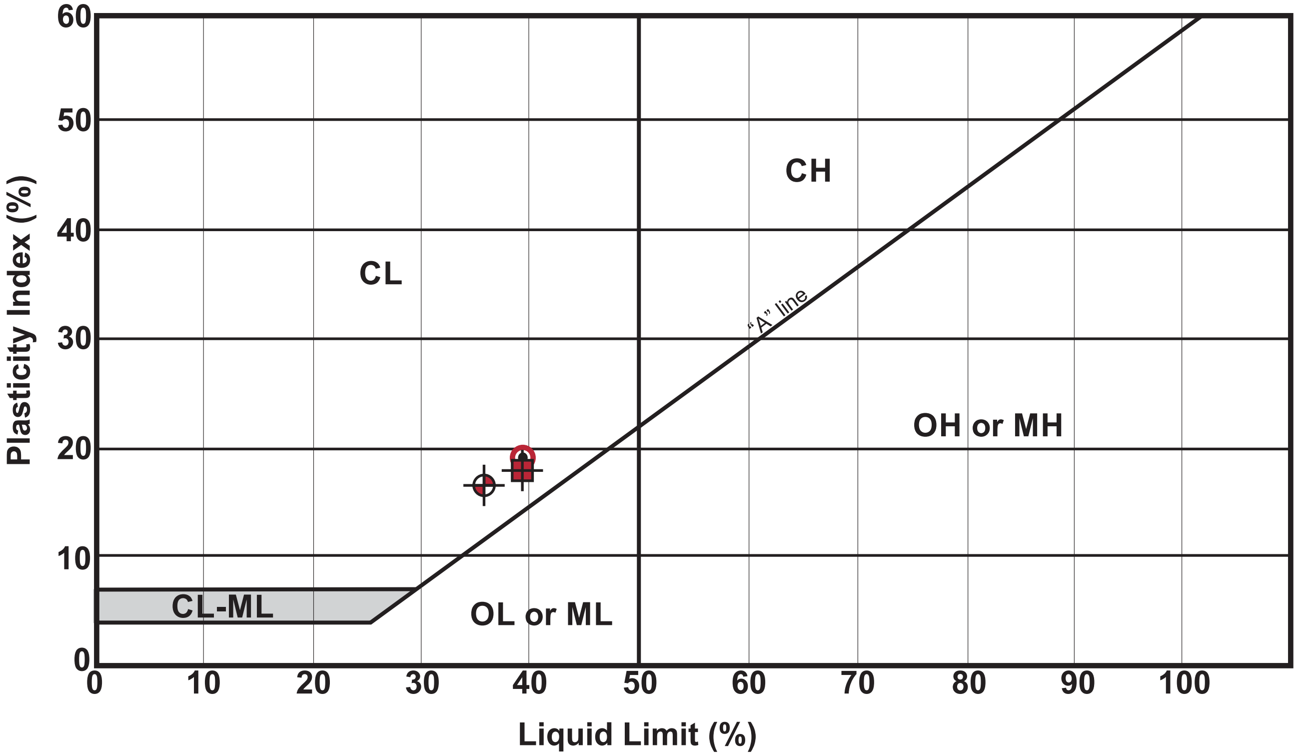
Washed Sieve Analyses: The percent soil fraction passing the No. 200 sieve (ASTM D1140) was determined on 14 samples of the subsurface soils to aid in the classification of these soils. Results of these tests are shown on the boring logs at the appropriate sample depths.

Grain Size Analyses: The particle size distribution (ASTM D422) was determined on three samples of soils to aid in the classification of these soils and determining the percent silt and clay. Results of these tests are shown on the boring logs at the appropriate sample depths.

Plasticity Index: Two Plasticity Index determinations (ASTM D4318) were performed on samples of the subsurface soils to measure the range of water contents over which this material exhibits plasticity. The Plasticity Index was used to classify the soil in accordance with the Unified Soil Classification System and to evaluate the soil expansion potential. Results of these tests are shown on the boring logs at the appropriate sample depths.

Consolidation: Two consolidation tests (ASTM D2435) were performed on relatively undisturbed samples of the subsurface clayey soils to assist in evaluating the compressibility property of this soil. Results of the consolidation tests are presented graphically in this appendix.

Plasticity Index (ASTM D4318) Testing Summary



Symbol	Boring No.	Depth (ft)	Natural Water Content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Passing No. 200 (%)	Group Name (USCS - ASTM D2487)
	EB-1	12.0	37	determined non-plastic			54	Sandy Silt (ML)
	EB-1	24.5	34	determined non-plastic			91	Silt (ML)
⊕	EB-2	13.5	33	36	20	16	—	Lean Clay (CL)
◎	EB-2	22.0	34	39	20	19	—	Lean Clay (CL)
⊞	EB-2	34.5	31	38	19	19	—	Lean Clay (CL)

Samples prepared in accordance with ASTM D421

CORNERSTONE
EARTH GROUP

Plasticity Index Testing Summary

130 Center Street
Santa Cruz, CA

Project Number
100-65-1

Figure Number
Figure B1

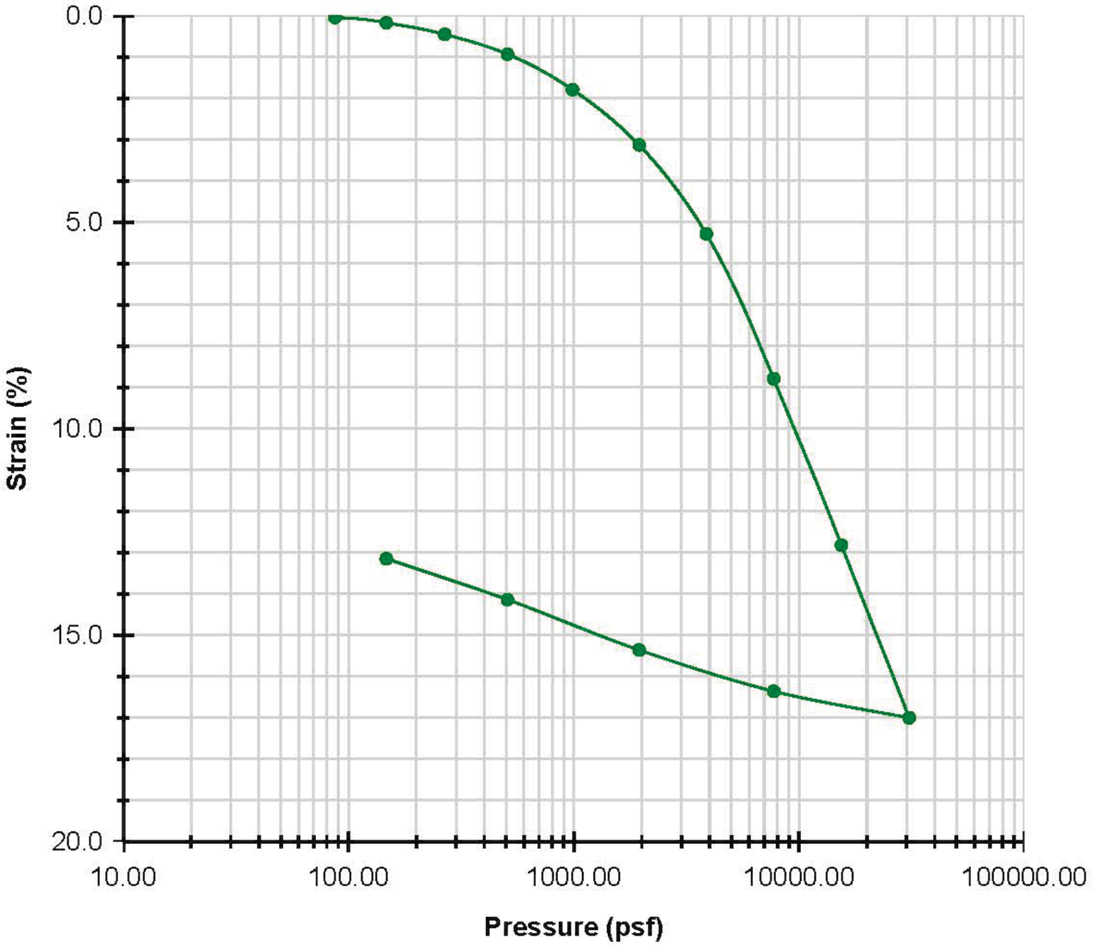
Date
July 2020

Drawn By
FLL

Consolidation Test ASTM D2435

Boring: EB-2 **Sample:** 7 **Depth:** 20.5’

Description: Lean Clay (CL)



	BEFORE	AFTER
Moisture (%)	34.3	26.6
Dry Density (pcf)	86.7	98.6
Saturation (%)	97.4	100.0
Void Ratio	0.96	0.72

CORNERSTONE EARTH GROUP

Strain-Log Curve - EB-2 @ 20.5’

130 Center Street
Santa Cruz, CA

Project Number 100-65-1

Figure Number Figure B2

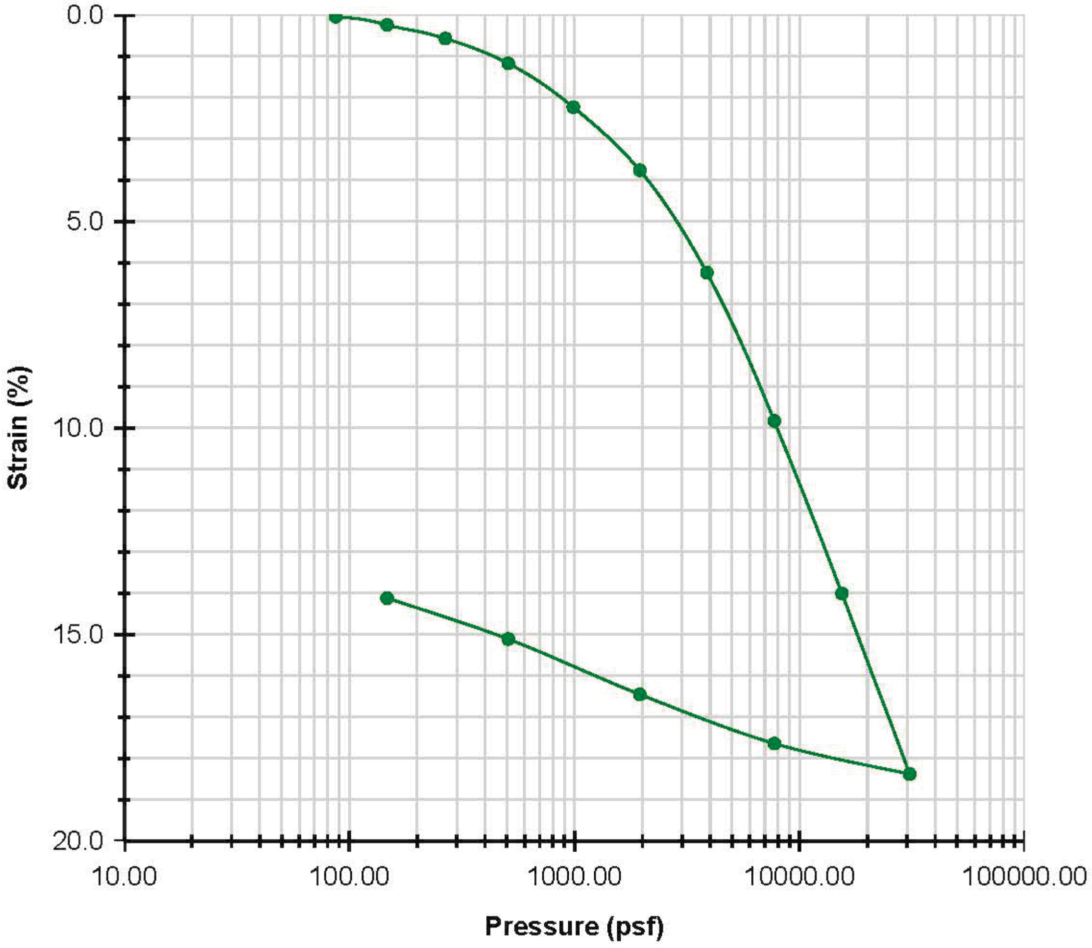
Date July 2020

Drawn By FLL

Consolidation Test ASTM D2435

Boring: EB-2 **Sample:** 11 **Depth:** 32.5’

Description: Lean Clay (CL)



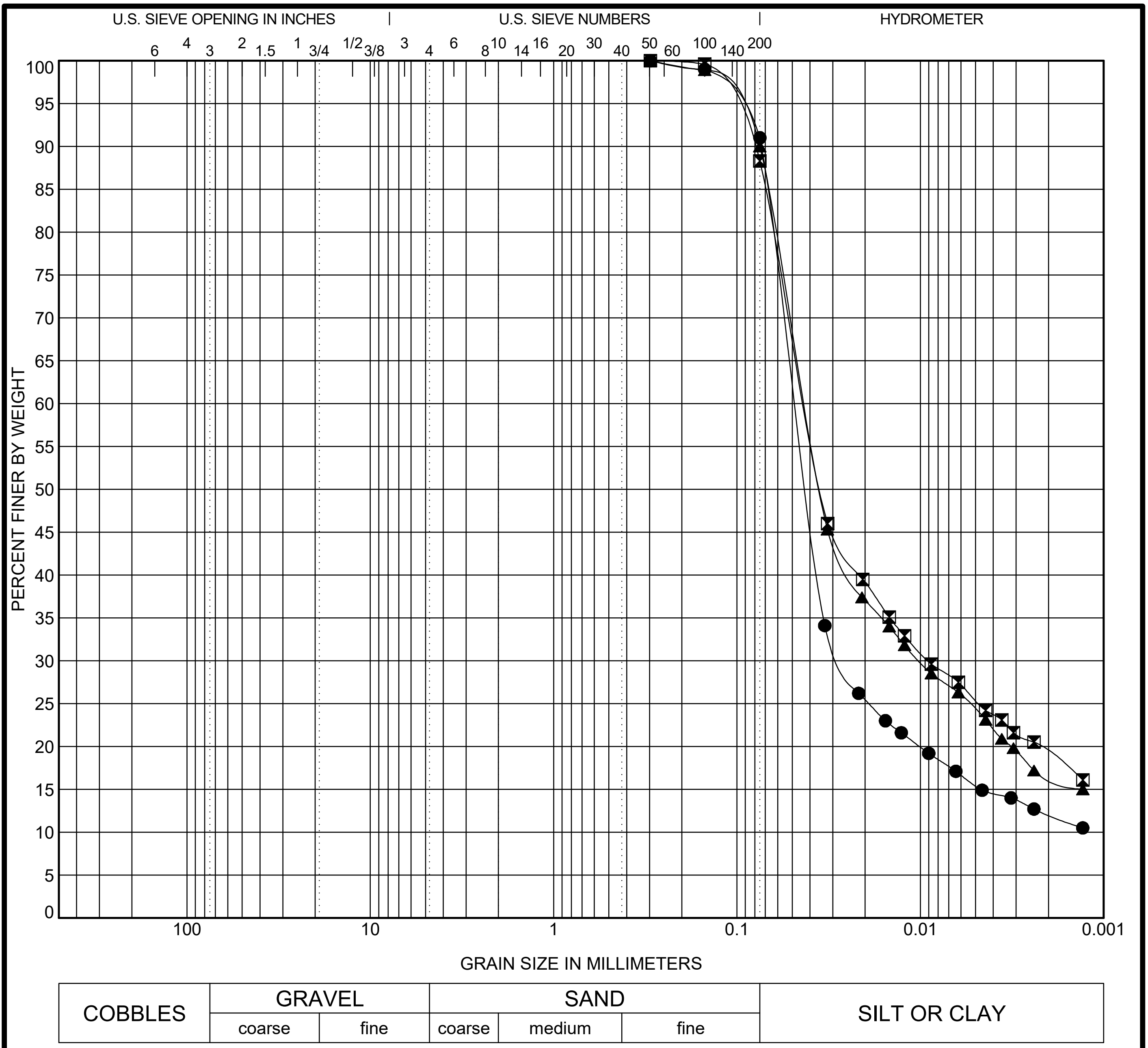
	BEFORE	AFTER
Moisture (%)	35.4	26.8
Dry Density (pcf)	85.4	98.2
Saturation (%)	97.5	100.0
Void Ratio	0.99	0.73

CORNERSTONE EARTH GROUP

Strain-Log Curve - EB-2 @ 32.5’

130 Center Street
Santa Cruz, CA

Project Number	100-65-1
Figure Number	Figure B3
Date	July 2020
Drawn By	FLL



Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**EB-1**	**23.5**	**Silt (ML)**					
☒	**EB-1**	**38.5**	**Lean Clay (CL)**	**31**	**19**	**12**		
▲	**EB-1**	**48.5**	**Silt (ML)**					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**EB-1**	**23.5**	**0.297**	**0.048**	**0.027**		**0.0**	**9.0**	**79 / 12**	
☒	**EB-1**	**38.5**	**0.297**	**0.042**	**0.009**		**0.0**	**11.7**	**69 / 19**	
▲	**EB-1**	**48.5**	**0.297**	**0.042**	**0.01**		**0.0**	**10.0**	**74 / 16**	

CORNERSTONE
EARTH GROUP

GRAIN SIZE DISTRIBUTION

Project: 130 Center Street

Location: Santa Cruz, CA

Number: 100-65-1

APPENDIX C: SITE CORROSIVITY EVALUATION

JDH CORROSION CONSULTANTS REPORT DATED SEPTEMBER 9, 2020

9/9/2020

jdh corrosion
consultants, inc.

130 Center Street
Santa Cruz, CA

SUBMITTED TO

John R. Dye, P.E., G.E.

Principal Engineer

Cornerstone Earth Group
1220 Oakland Boulevard, Suite 220
Walnut Creek, California 94596

JDH JOB NUMBER

2020206

jdh corrosion
consultants, inc.

Protecting the infrastructure
through innovative
Corrosion Engineering Solutions

September 9, 2020

Cornerstone Earth Group, Inc.
1220 Oakland Boulevard, Suite 220
Walnut Creek, California 94596

Attention: **John R. Dye, P.E., G.E.**
Principal Engineer

Subject: **Site Corrosivity Evaluation**
130 Center Street
Santa Cruz, CA
Project: 100-65-1

Dear John,

In accordance with your request, we have reviewed the laboratory soils data for the above referenced project site. Our evaluation of these results and our corresponding recommendations for corrosion control for the above referenced project foundations and buried site utilities are presented herein for your consideration.

Soil Testing & Analysis

Soil Chemical Analysis

Three (3) soil samples from the project site were chemically analyzed for corrosivity by **Cornerstone Earth Group**. Each sample was analyzed for chloride and sulfate concentration, pH, resistivity at 100% saturation and moisture percentage. The test results are presented in Cornerstone Earth Group Test Summary dated 8/20/2020. The results of the chemical analysis were as follows:

Soil Laboratory Analysis

Chemical Analysis	Range of Results	Corrosion Classification*
Chlorides	19 - 24 mg/kg	Non-corrosive*
Sulfates	89 - 112 mg/kg	Non-corrosive**
pH	6.6 – 7.1	Mildly Corrosive *
Moisture (%)	25.0 – 50.0 %	Not-applicable
Resistivity at 100% Saturation	1,340 – 2,149 ohm-cm	**Corrosive to Moderately Corrosive***

* With respect to bare steel or ductile iron.
** With respect to mortar coated steel

Discussion

Reinforced Concrete Foundations

Due to the low levels of water-soluble sulfates found in these soils, there is no special requirement for sulfate resistant concrete to be used at this site. The type of cement used should be in accordance with 2019 California Building Code (CBC) for soils which have less than 0.10 percent by weight of water soluble sulfate (SO_4) in soil and the minimum depth of cover for the reinforcing steel should be as specified in CBC as well.

Underground Metallic Pipelines

The soils at the project site are generally considered to be "corrosive" to ductile/cast iron, steel and dielectric coated steel based on the saturated resistivity measurements. Therefore, special requirements for corrosion control are required for buried metallic utilities at this site depending upon the critical nature of the piping. Pressure piping systems such as domestic and fire water should be provided with appropriate coating systems and cathodic protection, where warranted. In addition, all underground pipelines should be electrically isolated from above grade structures, reinforced concrete structures and copper lines in order to avoid potential galvanic corrosion problems.

LIMITATIONS

The conclusions and recommendations contained in this report are based on the information and assumptions referenced herein. All services provided herein were performed by persons who are experienced and skilled in providing these types of services and in accordance with the standards of workmanship in this profession. No other warrantees or guarantees, expressed or implied, is provided.

We thank you for the opportunity to be of service to ***Cornerstone Earth Group*** on this project and trust that you find the enclosed information satisfactory. If you have any questions, or if we can be of any additional assistance, please feel free to contact us at (925) 927-6630.

Respectfully submitted,

Brendon Hurley
JDH CORROSION CONSULTANTS, INC.
Field Technician

Mohammed Ali

REGISTERED PROFESSIONAL ENGINEER
MOHAMMED ALI
No. CR 1035
Exp. June 30, 2021
CORROSION
STATE OF CALIFORNIA

Mohammed Ali., P.E.
JDH Corrosion Consultants, Inc.
Senior Corrosion Engineer

CC: File 2020206

Corrositivity Tests Summary

CORNERSTONE
EARTH GROUP

Job Number 100-65-1

Job Name 130 Center Street

Location Santa Cruz, CA

Date Tested 8/20/2020

Tested By F. Leblo

Sample I.D.			Soil Visual Description	Moisture Content %	pH	Temp. at Testing C°	Resistivity (Ohm-cm) Corrected to 15.5 C°		Chloride Dry Wt. mg/kg	Sulfate Dry Wt. mg/kg
Boring	Sample No.	Depth, ft.					As Received	Saturated		
				ASTM D2216	ASTM G51		G57	ASTM G57	ASTM D4327	ASTM D4327
EB-1	4A	9.0	Gray Fat Clay (CH)	50.0	6.9	24.2	1,437	1,437	21	112
EB-2	2A	3.5	Dark brown Lean Clay with Sand (CL)	25.0	7.1	23.8	-	2,149	19	89
EB-2	4A	9.0	Gray Lean Clay (CL)	36.0	6.6	23.8	1,340	1,340	24	101

Corrositivity Tests Summary

CORNERSTONE
EARTH GROUP

Job Number 100-65-1
Job Name 130 Center Street
Location Santa Cruz, CA

Date Tested 8/20/2020
Tested By F. Leblo

Sample I.D.			Soil Visual Description	Moisture Content %	pH	Temp. at Testing C°	Resistivity (Ohm-cm) Corrected to 15.5 C°		Chloride Dry Wt. mg/kg	Sulfate Dry Wt. mg/kg
Boring	Sample No.	Depth, ft.					As Received	Saturated		
				ASTM D2216	ASTM G51		G57	ASTM G57	ASTM D4327	ASTM D4327
EB-1	4A	9.0	Gray Fat Clay (CH)	50.0	6.9	24.2	1,437	1,437	21	112
EB-2	2A	3.5	Dark brown Lean Clay with Sand (CL)	25.0	7.1	23.8	-	2,149	19	89
EB-2	4A	9.0	Gray Lean Clay (CL)	36.0	6.6	23.8	1,340	1,340	24	101

APPENDIX D: SITE SPECIFIC RESPONSE ANALYSIS AND NON-LINEAR EFFECTIVE STRESS LIQUEFACTION ANALYSIS

Robert Pyke, Consulting Engineer

September 9, 2020

John R. Dye, P.E., G.E.
Cornerstone Earth Group, Inc.
1220 Oakland Boulevard, Suite 220
Walnut Creek, CA 94596

Re: 130 Center Street
Santa Cruz, California
Earthquake Ground Motions, Liquefaction and Settlement

Dear John,

At your request I have conducted site response analyses in accordance with the provisions of ASCE 7-16 and developed an MCE design response spectrum for this project. By code, the DBE design response spectra is simply two-thirds of the MCE spectrum. I have also updated previous evaluations of the potential for earthquake-induced liquefaction and settlement using more complete and realistic analysis procedures.

The site is located in Santa Cruz with representative co-ordinates being latitude 37.6412 and longitude -122.4151. The site lies in an area of active seismicity with numerous active faults, but the seismic hazard is dominated by the real possibility of an earthquake with a magnitude up to 7.8 on the San Andreas fault at a distance of 18.6 km.

The location of various borings and CPT soundings and the subsurface conditions at the site are described in more detail in your companion geotechnical report. This report covers earthquake ground motions, liquefaction and settlement. Bedrock was not encountered by your borings and CPT soundings, however based on available geologic maps we have estimated that the depth to Tertiary mudstone is in the order of 150 feet. Based on data reported by Geovision (2018), I have assumed a shear wave velocity of 2500 ft/sec or 760 m/sec for the mudstone, which happens to be the boundary between Site Classes C and B.

Measured shear wave velocities are available from five SCPT soundings as shown in Figure 1.

1310 Alma Avenue, No. 201, Walnut Creek, CA 94596
Telephone 925.323.7338 E-mail bobpyke@attglobal.net

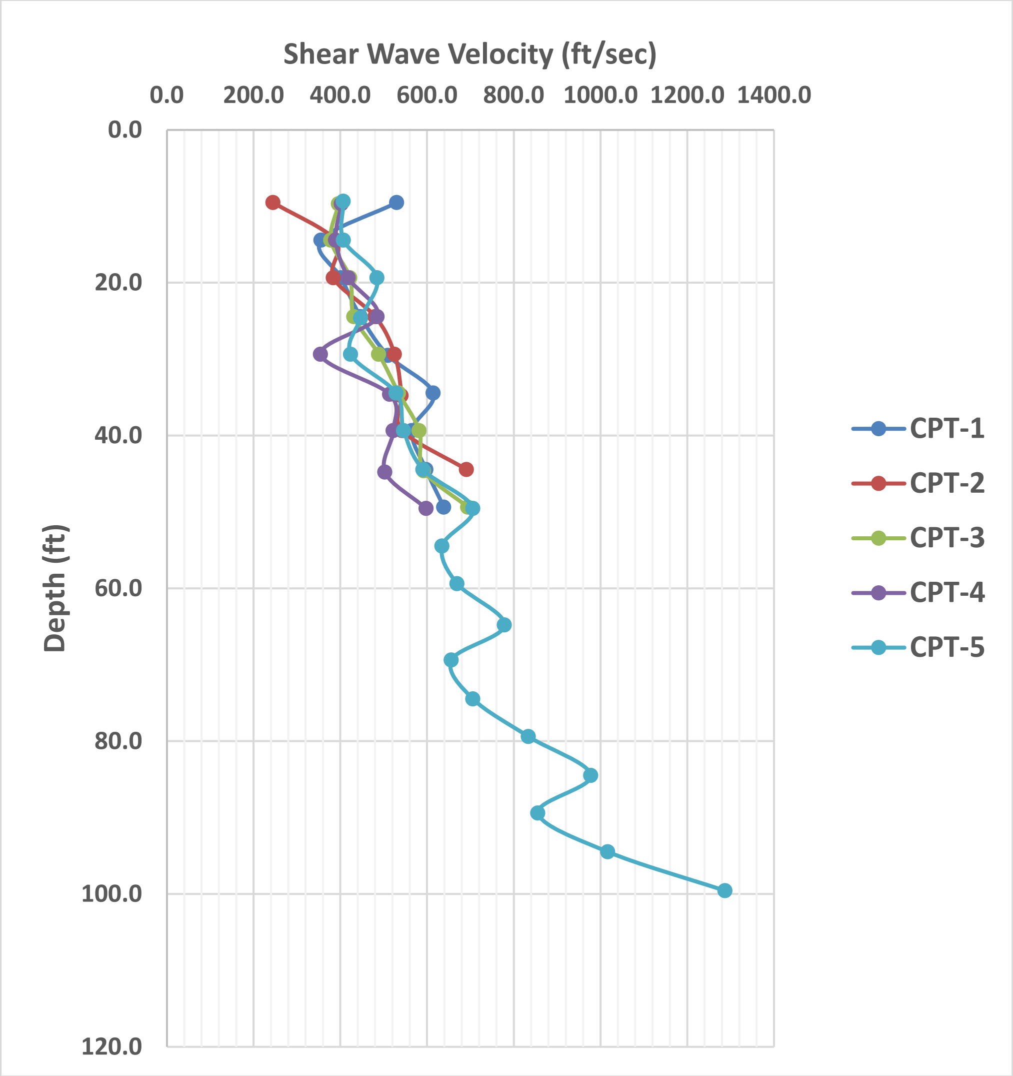


Figure 1 – Shear Wave Velocity Profiles

The average weighted average shear wave velocity over the top 30 meters, or 100 feet, V_{s30}, for CPT-5 is 608 ft/sec placing the site right at the lower end of Site Class D according to ASCE 7-16 and the 2019 CBC. Therefor a site- specific seismic hazard analysis and / or a site-specific site response analysis is required to determine the longer period ground motions for use in design. On the basis of previous experience which has shown that site-specific hazard analyses for Site Class D sites in the Bay Area tend to be conservative – because of the variability of such sites the standard deviation based on data recorded in similar tectonic regions worldwide is large, the hazard analysis results, whether governed by probabilistic or deterministic criteria, tend to be conservative. I have conducted nonlinear site response analyses that take into account the particular soil conditions at this site, rather than using averaged results over the entire site class.

Earthquake Input Motions

In order to conduct site response analyses, I have developed a target response spectrum and matching acceleration histories in the Tertiary mudstone. Figure 2 shows risk-adjusted, maximum direction response spectra for this location and the Site Class B/C boundary determined using both probabilistic and deterministic approaches. The probabilistic spectrum was obtained using the USGS web site https://earthquake.usgs.gov/hazards/interactive/ (detailed results are provided in Appendix A) and the deterministic spectrum was obtained using the predominant source and magnitude, a magnitude 7.8 earthquake on the San Andreas fault at a distance of 18+ km, obtained from the de-aggregation of seismic hazard on that web site and equal weighting of four of the five ground motion prediction equations (GMPEs) (excluding that of Idriss) using the NGAWest2 spreadsheet which is downloadable from https://peer.berkeley.edu/peer-nga-west2-research-program-releases-excel-file-five-horizontal-ground-motion-prediction. The risk adjustment factors were obtained from the SEA/OSHPD web site https://seismicmaps.org/ and the adjustment to "maximum direction" spectra was made using the factors suggested by Shahi and Baker (2014). As expected, the deterministic spectrum falls below the probabilistic spectrum and therefore governs.

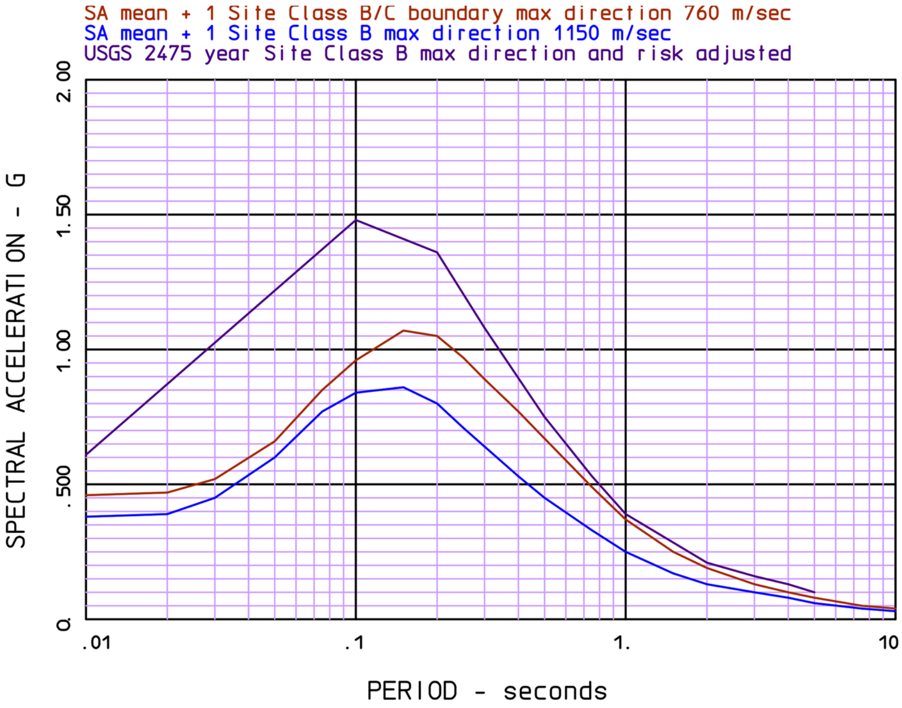


Figure 2 – ASCE 7-16 Site Class B Response Spectra

The target spectrum for matching acceleration histories shown subsequently in Figure 3 is slightly different from the deterministic spectrum shown in Figure 2 because the analysis is carried out with real values rather than artificial "maximum rotated" values. The target spectrum is based on the values obtained from PEER spreadsheet increased by 10 percent in accordance with Section 16.2.3.3 of ASCE 7-16 because I used spectral matching rather than scaling.

ASCE 7-16 requires the use of a minimum of five input motions for site response analyses, and, while it is not clear whether this means five single components or five pairs of components, for good measure I have used both horizontal components of each of five records that were generated by strike slip earthquakes such as may be expected on the San Andreas fault and two records from the Loma Prieta earthquake, which was a thrust event, as listed in Table 1.

I then modified the recorded motions so that they matched the Site Class B/C MCE spectrum for this location using the frequency domain program TINKER. The matches obtained to the target spectrum are shown in Figure 3. Plots of the individual time histories before and after matching have been saved and can be provided on request.

Table 1 – Selected Earthquake Records

Earthquake	**Record Name**	**Station Name**	**Year**	**M_w**	**R (km)**	**V_{s30} (m/s)**
Imperial Valley	IV02	El Centro 9	1940	6.95	6.09	213.4
Imperial Valley	IVEC4	El Centro 4	1979	6.53	7.05	208.9
Landers	JOS	Joshua Tree	1992	7.28	11.03	379.3
Kobe	NIS	Nishi-Akashi	1995	6.90	7.08	609.0
Kocaeli	YAR	Yarimca	1999	7.51	4.83	297.0
Loma Prieta	UC2	UCSC	1989	6.93	18.51	713.59
Loma Prieta	LOB	UCSC Lick Obs	1989	6.93	18.41	713.59

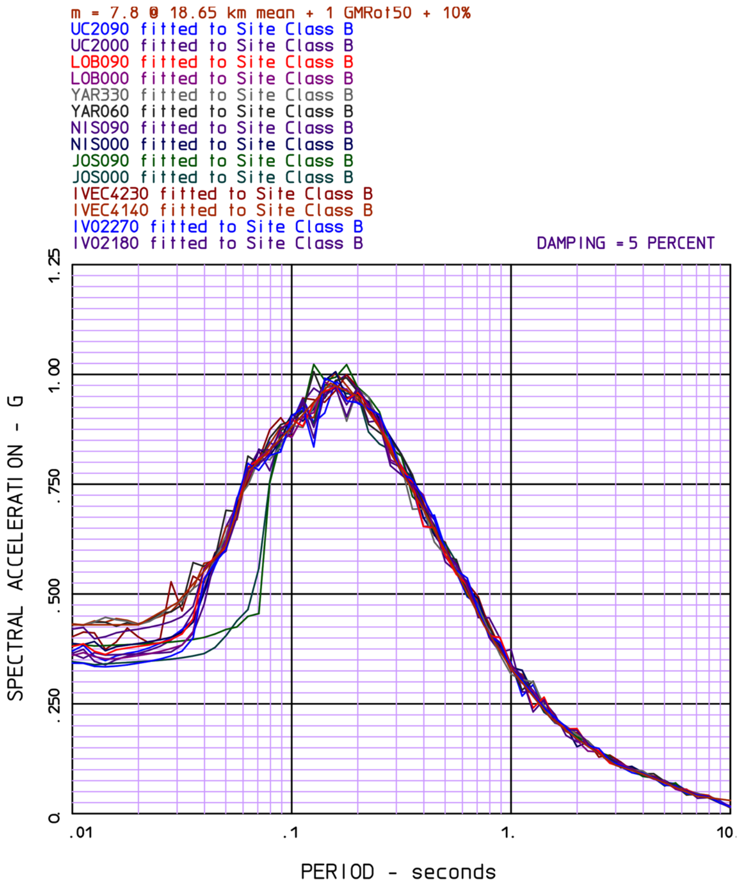


Figure 3 – Fit to ASCE 7-16 Site Class B Response Spectrum

Nonlinear Effective Stress Analyses

The first formal analyses of the potential for earthquake-induced liquefaction were developed at the University of California, Berkeley, in the late nineteen sixties. These analyses involved conducting “equivalent linear” site response analyses, extracting the histories of shear stresses in relevant layers, and comparing those shear stress histories with laboratory data obtained, usually, from cyclic triaxial tests. In spite of containing a number of simplifications and hence approximations, at that time very few engineers could conduct such analyses and so simplified methods of analysis, which worked backwards from the estimated peak ground surface acceleration, were developed, first for just the occurrence of liquefaction, and subsequently for seismic settlement and lateral spreading.

However, in recent years there has been growing recognition that simplified methods for evaluating the potential for liquefaction and hence settlement and lateral spreading due to earthquakes can be excessively conservative. This is particularly true of methods based on

CPT penetration resistance which tend to add additional conservatism. The reasons for this excessive conservatism have not been well or widely understood, and until very recently there has been no practical alternative to using these simplified methods. However, now Pyke (2015), Boulanger et al. (2016), Pyke (2019a), Pyke and North (2019) and Crawford et al. (2019), my presentation on estimating lateral spreading displacements, Pyke (2019b), and my technical note on estimating seismic settlements, Pyke (2020a), have spelled out the reasons that simplified analyses of liquefaction, settlement and lateral spreading are generally quite conservative.

These publications provide several examples including a case history involving Lum Elementary School in Alameda CA, in which excessive conservatism led to particularly adverse social impacts. Pyke (2019 (a)) and Pyke and North (2019) also describe an improved method for evaluating liquefaction and settlement which uses bi-directional, nonlinear effective stress site response analyses as embodied in the computer program TESS2. The estimates of settlement made by TESS2 are based on data from Pyke (1973) but site-specific data can be substituted if it is available or acquired. Pyke (2019 (b)), also describes how TESS2 can be used to make improved estimates of lateral spreading. These improved analyses are consistent with an emerging consensus, see for example Ntritsos et al. (2018), Cubrinovski (2019), Hutabarat and Bray (2019), Kramer (2019) and Olson et al. (2020), that nonlinear effective stress site response analyses are necessary to understand case histories of liquefaction, let alone to make forward predictions. They also provide the most accurate method for conducting site-specific seismic hazard and/or site response analyses such as are generally required for Site Classes D, E and F under ASCE 7-16 and the 2019 CBC.

Evaluation of the Potential for Liquefaction

Any evaluation of the potential for liquefaction, and hence seismic settlement and lateral spreading, should start not with analysis of any kind but by asking the question: "is there any record of liquefaction of similar soils in a similar tectonic environment? See Pyke (1995, 2003, 2015) and Semple (2013). For the 130 Center Street site the short answer is "yes" with respect to the silts found between depths of 12 and 26 feet in CPT-1 and EB-1 and "maybe" with respect to the more sandy soils found between 28 and 37 feet, but in order to make an appropriate judgement regarding the amount of excess pore pressure development that is included in the TESS2 analyses, the following factors were considered.

Clay content. A perhaps surprising feature of this site is that while the silts and sands found between 12 and 37 feet in EB-1 are generally non-plastic, generally similar soils encountered in EB-2 and the remaining four CPTs have plastic fines and measurable plasticity indexes and are thus not susceptible to liquefaction and settlement with significant consequences. These soils may develop minor excess pore pressures under heavy shaking and show minor settlement on reconsolidation, but they are not susceptible to classic liquefaction and seismic settlement.

<u>SPT N-Values</u>. The recorded SPT N-Values (blowcounts) corrected for hammer energy and normalized for overburden pressure as recommended by Boulanger and Idriss (2014) are shown in Figure 4.

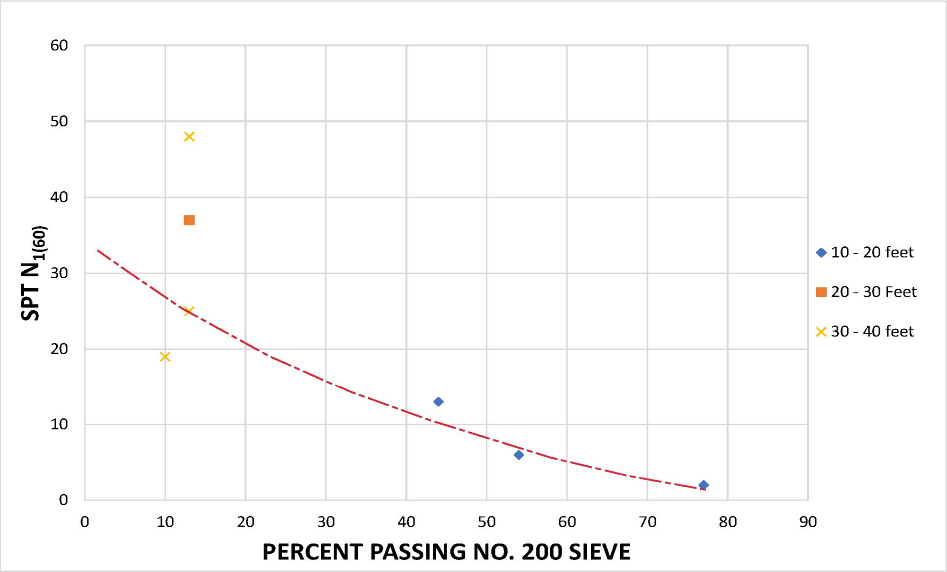


Figure 4 – Normalized SPT N-Values

It may be seen in Figure 4 that the N-Values measured in the silty soils can be projected to normalized clean sand N-Values in the order of 20-25 blows per foot (bpf) and that the normalized clean sand N-Values in the more sandy soils might be taken as 25-35 bpf for design purposes.

<u>SPT N-Values Interpreted from CPT</u>. Robertson and Wride (1998) and Robertson and Shao (2010) provide procedures for normalizing cone tip resistance for overburden pressure and for converting the cone tip resistance to an SPT N-Values. They also provide a correction to “clean sand” values but that has not been applied to the data shown in Figure 5. Again, the projected interpreted clean sand (I_c of less than say 1.7) blowcounts are in the order of 20-25 bpf for the silty soils and 25-35 bpf for the sandier soils.

<u>Relative Densities Interpreted from CPT</u>. Using the correlation based on calibration chamber tests performed in Italy on freshly deposited, clean sands (Jamoilkowski et al.,

2003), the relative densities interpreted from the CPT measurements are shown in Figure 6. Projection of the values shown in Figure 6 to clean sand values, again I_c of less than say 1.7, suggests relative densities in the order of 60-65% for the silty soils and 70% for the more sandy soils. Relative densities are required as input to TESS2 for estimating the seismic settlement. Factors of 0.75 and 0.5 were also applied to reduce the seismic settlements computed using the data from Pyke (1973) on Monterey No. 0 sand that is built into TESS2 for the silty and more sandy soils, respectively.

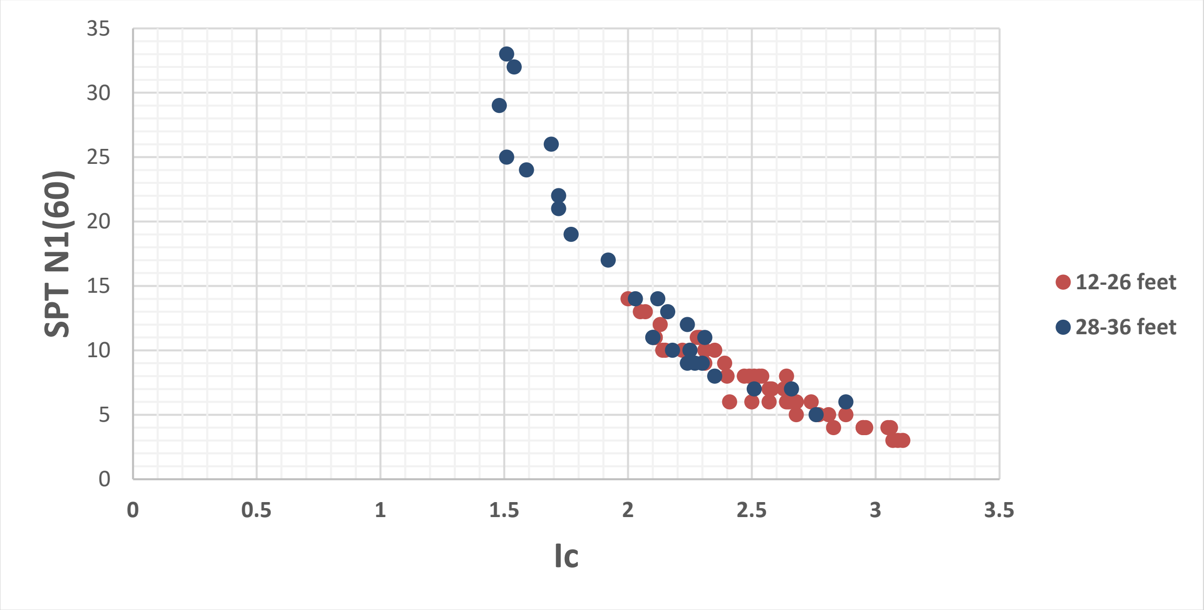


Figure 5 – SPT Blowcounts Interpreted from CPT-1

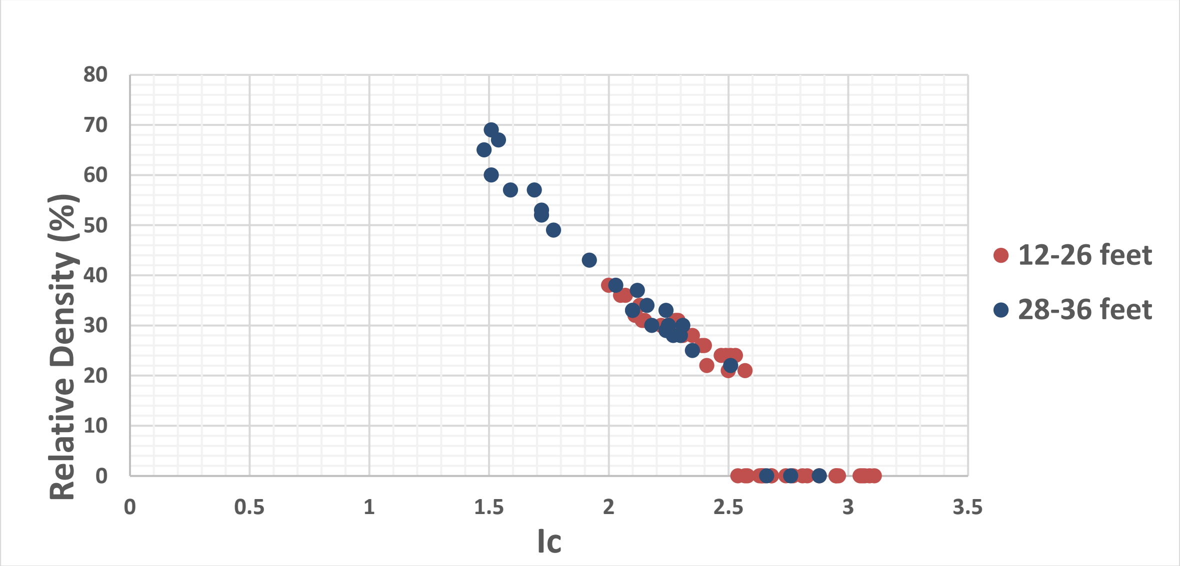


Figure 6 – Relative Densities Interpreted from CPT-1

Measured Shear Wave Velocities. Multiple publications starting with Andrus and Stokoe (2000) indicate that the occurrence of liquefaction in sands with a shear wave velocity of greater than about 700 ft/sec is unlikely. The three shear wave velocities measured in the critical silty stratum in EB-1 between 12 and 26 feet, when normalized for overburden pressure, fall between 420-450 fps, so this stratum is confirmed to be at least moderately susceptible to liquefaction and seismic settlement. The two measurements in the more sandy stratum between 28 and 37 feet, when normalized for overburden pressure, are approximately 500 and 600 fps, but the lower of these two number is impacted by a clayey layer between 26 and 28 feet which likely has a lower shear wave velocity. Thus, the value of 600 fps is likely more representative of the sandy stratum and indicates, consistent with the SPT and CPT data, that while some excess pore pressure development in this stratum is possible, complete liquefaction and large seismic settlements are unlikely.

The magnitude of the excess pore pressures that are developed in TESS2 are controlled by specifying values of tau/sigma, the cyclic stress ratio causing liquefaction in 10 cycles assuming uniform cycles of loading such as are applied in laboratory tests. On the basis of Figure 6.3d in Boulanger and Idriss (2014), I selected values of 0.3 for the silty soils and 0.6 for the sandier soils, consistent with clean sand normalized blowcounts of 20-25 bpf and 25-35 bpf.

TESS2 Analyses and Results

I conducted site response analyses using the new nonlinear site response analysis program TESS2. TESS2 employs the same explicit finite difference solution of the one-dimension wave propagation problem and the same HDCP soil model as were used in the earlier program TESS (Pyke, 1979, 1993, 2004). TESS has been verified and validated in a number of studies including Kwok et al. (2007) and Stewart et al. (2008). Various issues involved in the conduct of nonlinear site response analyses are discussed in Pyke (2020b).

In conventional "equivalent linear" analyses of site response it is necessary to specify the shear wave velocity, or the shear modulus at small strains, G_{max}, for each layer along with a "modulus reduction curve", and a modulus reduction curve of this kind can also be used as the "backbone" curve for constructing simple nonlinear models of shear stress – shear strain behavior. Pyke et al. (1993) constructed a consistent family of shear modulus reduction curves in terms of the reference strain, which is equal to τ_{max}, the asymptotic value of the shear stress at large strains, divided by G_{max}, the shear modulus at small strains. The value of τ_{max} may be much greater than the conventional shear strength under monotonic loading as a result of both cyclic and rate of loading effects. For a plain hyperbola the reference strain is equal to the shear strain at which G/ G_{max} equals 0.5.

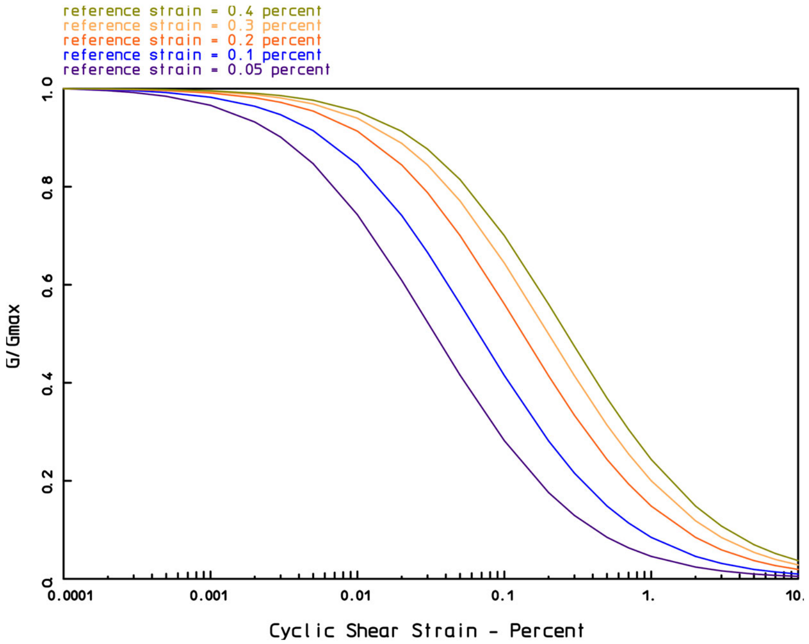


Figure 7 – Modulus Reduction Curves as a Function of Reference Strain

Typical modulus reduction curves in terms of reference strain are shown in Figure 7. The modulus reduction curve for a reference strain of 0.1 percent closely matched the upper bound of the modulus reduction curves for sands given by Seed and Idriss (1971), which is widely accepted as a good representation of the modulus reduction curve for relatively young, clean sands. Clayey soils exhibit less nonlinearity than sands and have modulus reduction curves with larger reference strains. For instance, young Bay Mud, a silty clay, has a reference strain of about 0.3 percent.

The new program, TESS2, runs two horizontal components of motion simultaneously and, if appropriate, adds the excess pore pressures generated by each component in accordance with the recommendation of Seed et al. (1978). Seismic settlements are computed as described by Pyke (2019a), using data from Pyke (1973) factored as necessary for the particular site conditions.

I have made a number of runs with TESS2 using all seven two-component input motions for a 150 feet deep profile in order to explore the effect on the computed ground surface motions of the soil properties and the presence of the planned building. These runs were labelled as follows:

bh1 – free-field analysis for EB-1 / CPT-1
bh1bp – under basement profile
bh1bpd – under basement profile with drainage
bh1bpi –under basement profile with suppression of excess pore pressures
bh2 – free-field analysis for EB2 / CPT-5
bh2bp – under basement profile

The details of the assumed input parameters and the results are shown for these runs in the printed outputs from TESS2 that are included in Appendix B and the plots of surface response spectra that are shown in Figures 8-13. Note that these results are for the "mean + one standard deviation" earthquake generated by rupture of the San Andreas fault which, very approximately, might occur once in a thousand years. Smaller earthquakes, which might occur more frequently, will have relatively smaller effects.

The mapped spectra acceleration parameters and the corresponding MCE spectral acceleration parameters for Site Class D at this location were obtained from the SEA/OSHPD web site https://seismicmaps.org/, as shown in Appendix A, and Supplement No.1 to ASCE 7-16, and the code spectrum for Site Class D and a spectrum equal to 70 percent of the code values, the minimum allowed for embedded structures in accordance with Section 19.2.3 (4), are also shown on these figures.

The analyses suggest that for that part of the foundation soils represented by EB-1 and CPT-1 the silty stratum between 12 and 26 feet will liquefy in a major earthquake but the more sandy stratum from 28 to 37 feet will not. The estimated seismic settlement of the ground surface is 2 inches outside the building footprint and 2 ½ inches under the building. The influence of the building mass increases the cyclic shear stresses and strains under the building relative to the free-field but dramatically reduces the motion at the underside of the basement. This is not unlike the behavior of the proverbial "sausage on a skillet" which moves less than the skillet itself as the skillet is shaken horizontally.

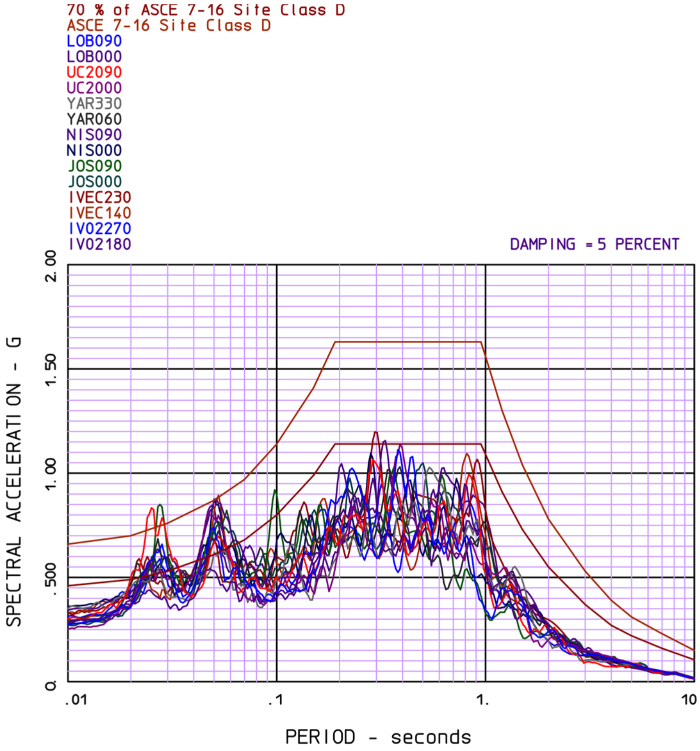


Figure 8 – Computed Ground Surface Spectra for EB-1 / CPT-1

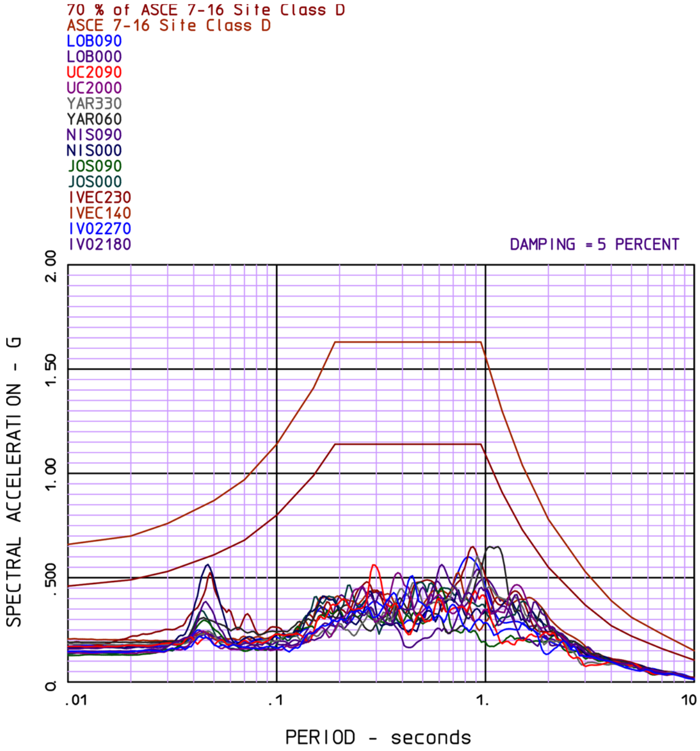


Figure 9 – Computed Spectra Under Basement for EB1 /CPT-1

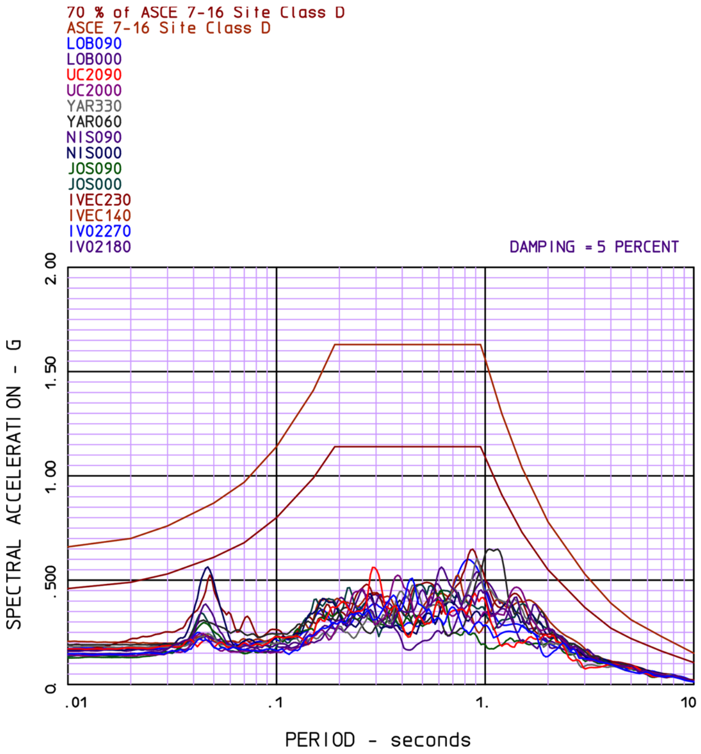


Figure 10 – Computed Spectra Under Basement with Drainage

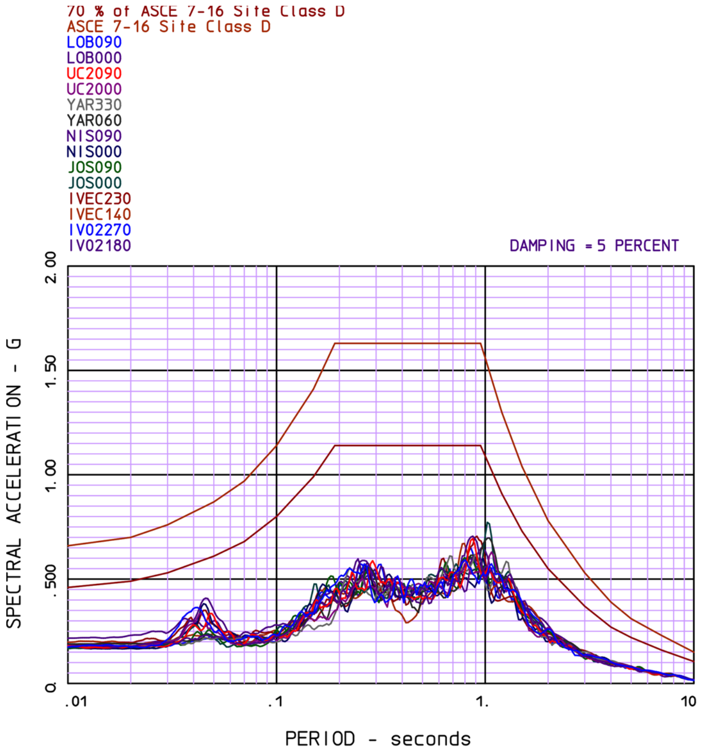


Figure 11 – Computed Spectra Under Basement with Suppression of EPP

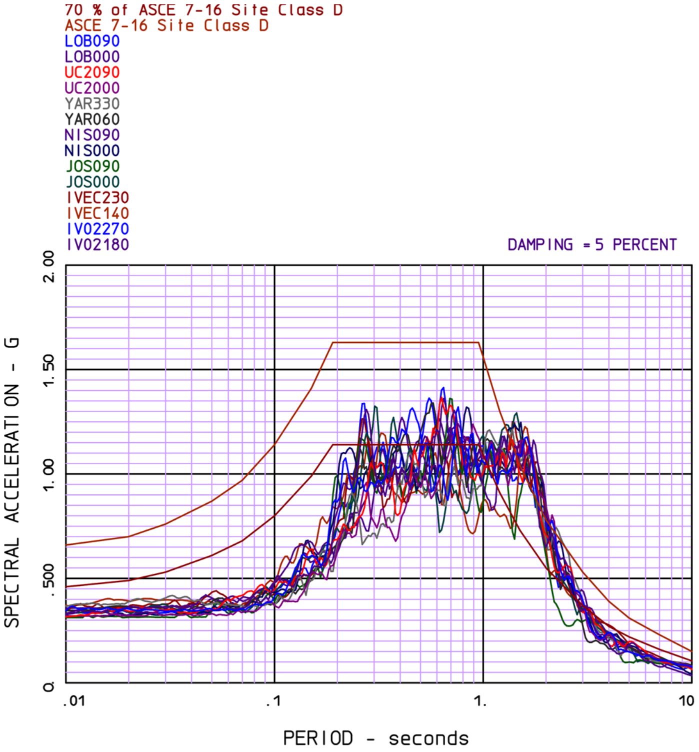


Figure 12 – Computed Ground Surface Spectra for EB-2 / CPT-5

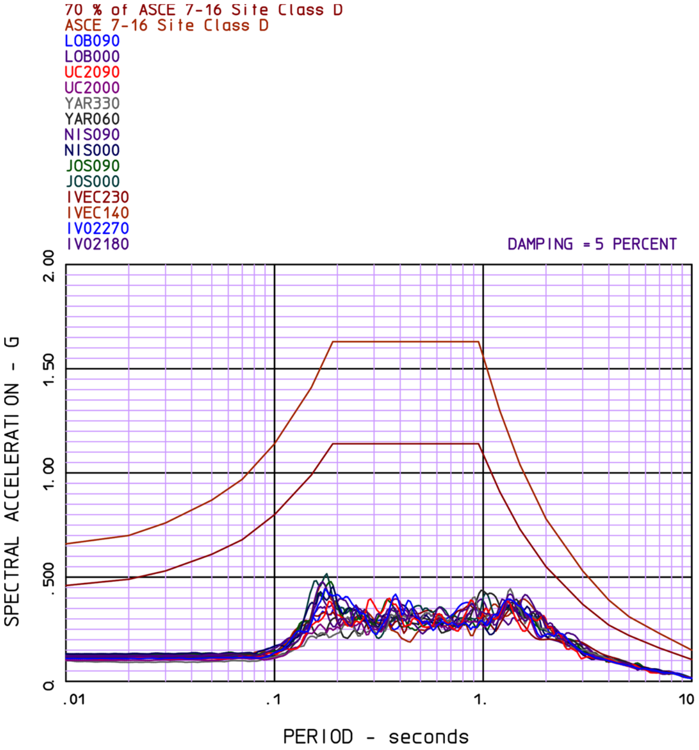


Figure 13 – Computed Spectra Under Basement for EB2 /CPT-5

Run bh1bpd – under basement profile with drainage – suggest that because of the relatively low hydraulic conductivity of the silt layer that it would not be possible to drain off excess pore pressures during the earthquake in order to prevent complete liquefaction and limit seismic settlements and that even use of stone columns for that purpose might be problematic. Run bh1bpi –under basement profile with suppression of excess pore pressures – was intended to indicate how much the under-basement motions in the area underlain by soils similar to EB-1 / CPT-1 might increase if liquefaction did not occur. If liquefaction were to be mitigated by installing stiffer elements such as stone columns or cement-soil-mixed or jet grouted columns, the motions might be higher still but it seems unlikely that they would exceed 70% of the code spectrum for Site Class D

These analyses, which use a simple one-dimensional calculation of site response and assume that the building response is dominated by the motion under the building rather than by the larger free-field motions, are of course approximate, but are likely just as accurate as a much more complicated 3D nonlinear analysis of the foundation and the structure would be. I believe that they can be relied on for design in those cases where the dimensions of the building in plan are rather greater than the depth of embedment and the height of the podium structure.

Summary of Findings

The values for 70% of the code spectrum for Site Class D shown below in Table 2 are recommended for the building design. The values of S_{MS} and S_{M1} are 1.14 and 1.09 g. S_{DS} and S_{D1} by code are two-thirds of these value or 0.76 and 0.73 g.

At CPT-1/EB-1, the estimated seismic settlement of the ground surface is estimated at approximately 2 inches outside the building footprint and approximately 2½ inches under the building. Seismic settlement in the vicinity of CPT-2 through CPT-5 is estimated to be less than 1 inch. The influence of the building mass increases the cyclic shear stresses and strains under the building relative to the free-field but dramatically reduces the motion at the underside of the basement.

Table 2 – Recommended MCE Spectrum

PERIOD	S_a
seconds	g
0.01	0.46
0.02	0.49
0.03	0.53
0.05	0.61
0.07	0.68
0.1	0.80
0.15	0.99
0.19	1.14
0.95	1.14
1.0	1.09
1.2	0.91
1.5	0.73
2.0	0.55
3.0	0.37
4.0	0.27
5.0	0.22
7.0	0.16
10.0	0.105

I would be happy to address any questions that you or the structural engineer might have.

Sincerely,

Robert Pyke

Robert Pyke, Ph.D, G.E.

REGISTERED PROFESSIONAL ENGINEER
ROBERT PYKE
GE00702
Exp. 03-31-21
GEOTECHNICAL
STATE OF CALIFORNIA

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Appendix A

Output from SEA/OSHPD and USGS Hazard Tools

130 Central Santa Cruz

Latitude, Longitude: 36.9662, -122.0263

Date	8/13/2020, 12:28:33 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	B - Rock

Type	Value	Description
S_S	1.628	MCE_R ground motion. (for 0.2 second period)
S_1	0.621	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.465	Site-modified spectral acceleration value
S_{M1}	0.496	Site-modified spectral acceleration value
S_{DS}	0.977	Numeric seismic design value at 0.2 second SA
S_{D1}	0.331	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	0.9	Site amplification factor at 0.2 second
F_v	0.8	Site amplification factor at 1.0 second
PGA	0.683	MCE_G peak ground acceleration
F_{PGA}	0.9	Site amplification factor at PGA
PGA_M	0.615	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.628	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.748	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	3.013	Factored deterministic acceleration value. (0.2 second)
S1RT	0.621	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.681	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.022	Factored deterministic acceleration value. (1.0 second)
PGAd	1.223	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.932	Mapped value of the risk coefficient at short periods
C_{R1}	0.912	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

130 Central Santa Cruz

Latitude, Longitude: 36.9662, -122.0263

Date	8/13/2020, 12:00:49 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S_S	1.628	MCE_R ground motion. (for 0.2 second period)
S_1	0.621	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.628	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	1.085	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	0.683	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.752	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	1.628	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	1.748	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	3.013	Factored deterministic acceleration value. (0.2 second)
S1RT	0.621	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.681	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	1.022	Factored deterministic acceleration value. (1.0 second)
PGAd	1.223	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.932	Mapped value of the risk coefficient at short periods
C_{R1}	0.912	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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U.S. Geological Survey - Earthquake Hazards Program

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

⌃ Input

Edition

Dynamic: Conterminous U.S. 2014 (u…

Latitude

Decimal degrees

36.9662

Longitude

Decimal degrees, negative values for western longitudes

-122.0263

Site Class

1150 m/s (Site class B)

Spectral Period

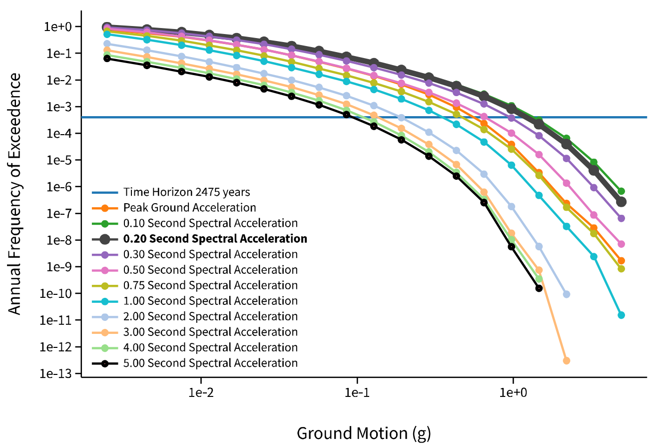
0.20 Second Spectral Acceleration

Time Horizon

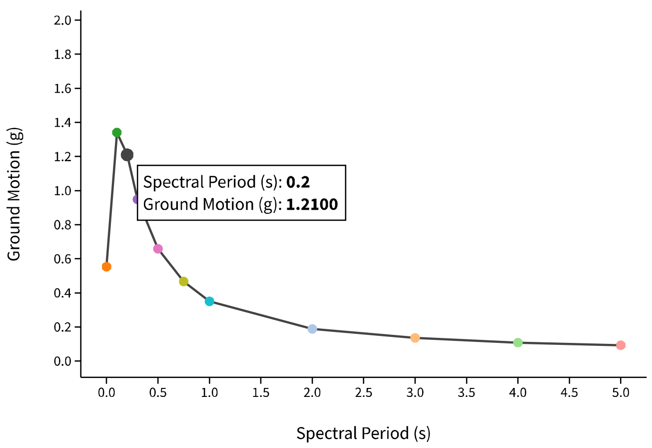
Return period in years

2475

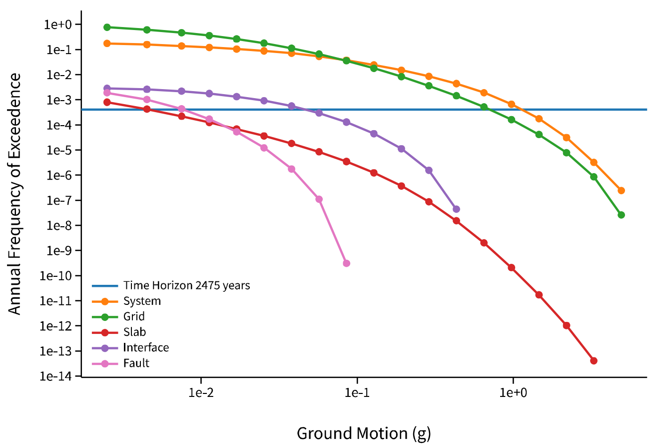
Hazard Curve



Hazard Curves



Uniform Hazard Response Spectrum



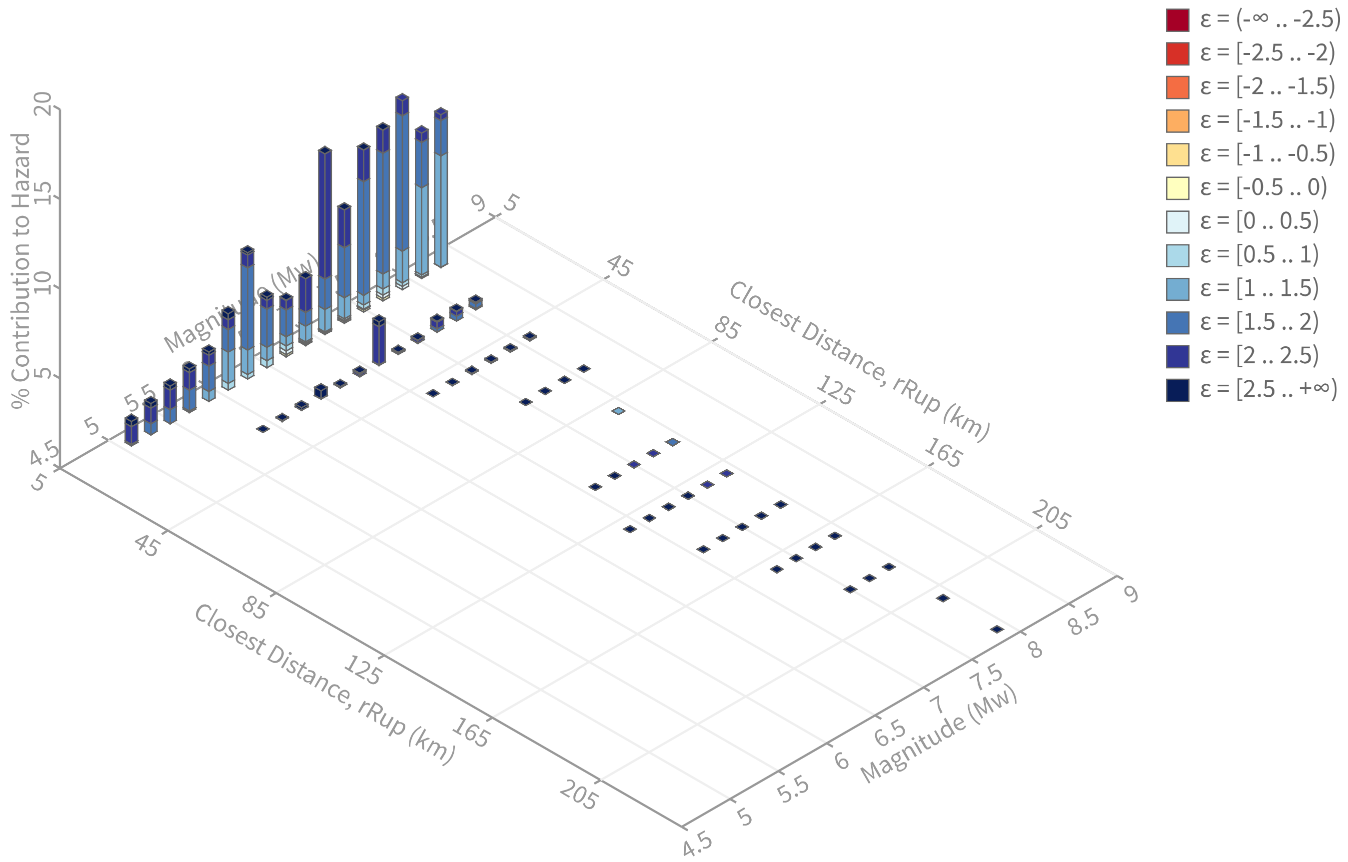
Component Curves for 0.20 Second Spectral Acceleration

View Raw Data

^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
0.2 s SA ground motion: 1.2099942 g

Recovered targets

Return period: 2906.8696 yrs
Exceedance rate: 0.00034401268 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.06 %

Mean (over all sources)

m: 7.18
r: 15.34 km
ε_0: 1.75 σ

Mode (largest m-r bin)

m: 7.88
r: 17.74 km
ε_0: 1.62 σ
Contribution: 10.53 %

Mode (largest m-r-ε_0 bin)

m: 7.87
r: 18.38 km
ε_0: 1.68 σ
Contribution: 7.54 %

Discretization

r: min = 0.0, max = 1000.0, Δ = 20.0 km
m: min = 4.4, max = 9.4, Δ = 0.2
ε: min = -3.0, max = 3.0, Δ = 0.5 σ

Epsilon keys

ε0: [-∞ .. -2.5)
ε1: [-2.5 .. -2.0)
ε2: [-2.0 .. -1.5)
ε3: [-1.5 .. -1.0)
ε4: [-1.0 .. -0.5)
ε5: [-0.5 .. 0.0)
ε6: [0.0 .. 0.5)
ε7: [0.5 .. 1.0)
ε8: [1.0 .. 1.5)
ε9: [1.5 .. 2.0)
ε10: [2.0 .. 2.5)
ε11: [2.5 .. +∞]

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							42.00
San Andreas (Santa Cruz Mts) [1]		18.56	7.76	1.75	121.893°W	37.099°N	38.83	19.69
San Gregorio (North) [21]		16.59	7.54	1.80	122.202°W	36.915°N	249.83	5.61
Monterey Bay-Tularcitos [12]		9.85	6.72	1.60	122.109°W	36.908°N	228.64	4.59
Reliz [2]		8.77	7.12	1.34	122.090°W	36.907°N	220.86	1.92
Zayante-Vergeles [3]		7.06	7.47	0.21	121.939°W	37.048°N	40.15	1.80
San Andreas (Santa Cruz Mts) [2]		18.57	7.13	2.08	121.884°W	37.093°N	41.83	1.65
San Andreas (Santa Cruz Mts) [0]		19.78	7.68	1.89	121.943°W	37.134°N	21.62	1.63
San Andreas (Santa Cruz Mts) [3]		20.62	7.16	2.17	121.820°W	37.057°N	61.02	1.11
UC33brAvg_FM32	System							38.49
San Andreas (Santa Cruz Mts) [1]		18.56	7.76	1.75	121.893°W	37.099°N	38.83	20.57
San Gregorio (North) [21]		16.59	7.56	1.78	122.202°W	36.915°N	249.83	5.49
Monterey Bay-Tularcitos [12]		9.85	6.60	1.65	122.109°W	36.908°N	228.64	2.87
San Andreas (Santa Cruz Mts) [2]		18.57	7.15	2.08	121.884°W	37.093°N	41.83	1.70
Reliz [2]		8.77	7.11	1.34	122.090°W	36.907°N	220.86	1.68
San Andreas (Santa Cruz Mts) [0]		19.78	7.69	1.89	121.943°W	37.134°N	21.62	1.50
San Andreas (Santa Cruz Mts) [3]		20.62	7.15	2.19	121.820°W	37.057°N	61.02	1.07
UC33brAvg_FM31 (opt)	Grid							11.50
PointSourceFinite: -122.026, 37.034		8.40	5.90	1.70	122.026°W	37.034°N	0.00	2.08
PointSourceFinite: -122.026, 37.034		8.40	5.90	1.70	122.026°W	37.034°N	0.00	2.08
PointSourceFinite: -122.026, 37.007		6.67	5.83	1.48	122.026°W	37.007°N	0.00	1.89
PointSourceFinite: -122.026, 37.007		6.67	5.83	1.48	122.026°W	37.007°N	0.00	1.89
UC33brAvg_FM32 (opt)	Grid							8.01
PointSourceFinite: -122.026, 37.034		8.35	5.91	1.71	122.026°W	37.034°N	0.00	1.45
PointSourceFinite: -122.026, 37.034		8.35	5.91	1.71	122.026°W	37.034°N	0.00	1.45
PointSourceFinite: -122.026, 37.007		6.73	5.71	1.62	122.026°W	37.007°N	0.00	1.33
PointSourceFinite: -122.026, 37.007		6.73	5.71	1.62	122.026°W	37.007°N	0.00	1.33

Appendix B
Example Outputs
Nonlinear Site Response Analyses

The following pages show the printed output from TESS2 for six runs showing the assumed input parameters and some of the results. The printed results are shown for all seven pairs of input motions for the free-field analyses bh1 and bh2, and the results are shown for just the IV02 input motions for the under basement motions bh1bp, bh1bpd, bh1bpi and bh2bp.

Definitions of key column headings are as follows:

In the INPUT data:

SIGV - vertical effective stress
VS - shear wave velocity
GMAX - shear modulus at low strains
TAUMAX - asymptote of stress-strain curve under rapid, cyclic loading
GAMREF – reference strain - ratio of TAUMAX to shear modulus at low strains

In the OUTPUT:

TAUMAX – is now the peak shear stress during the loading
GAMMAX – is the peak cyclic shear strain
DELTA, DETAG and DETAU – are degradation indices generally used for clayey soils. Unity indicates no degradation.
UMAX – maximum excess pore pressure ratio at any time. Unity indicates initial liquefaction.
UFINAL – excess pore pressure ratio at the end of the specified input motion

```
**************************************************
**************************************************

 TESS2 - Version 3.00C
 Copyright 2020 Robert Pyke
 Built by rmp on 08/22/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: bh1


****************************************
130 Center Street  EB-1
****************************************
Free-field  150-foot profile
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS NOT INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  1         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  2         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  3         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  4         0.02      1.00      0.00      0.00      0.00
```

```
PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E        SG        RG        ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G
     4       3       0.300       10         2.00         0.10         2.00
     5       3       0.300       10         2.00         0.10         2.00
     6       3       0.300       10         2.00         0.10         2.00
     7       3       0.300       10         2.00         0.10         2.00
     8       4       0.600       10         2.00         0.10         2.00
     9       4       0.600       10         2.00         0.10         2.00


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR
      4      60    0.75
      5      61    0.75
      6      62    0.75
      7      63    0.75
      8      70    0.50
      9      70    0.50


PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3       1    1.00    0.50
      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   5.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0050 SECONDS
```

```
 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV       VS        GMAX      TAUMAX   GAMREF     TTR

     1         1      4.00    0.110                 0.22      530.00      959.60    1.919    0.200    0.662
     2         1      4.00    0.110                 0.69      530.00      959.60    1.919    0.200    0.662
     3         1      4.00    0.110                 0.88      530.00      959.60    1.919    0.200    0.662
     4         3      3.00    0.115   1.00  0.50    1.06      350.00      437.50    0.656    0.150    0.583
     5         3      3.00    0.115   1.00  0.50    1.22      400.00      571.43    0.857    0.150    0.667
     6         3      4.00    0.115   1.00  0.50    1.40      425.00      645.09    0.968    0.150    0.531
     7         3      4.00    0.115   1.00  0.50    1.61      450.00      723.21    1.085    0.150    0.562
     8         4      5.00    0.120   1.00  0.80    1.86      500.00      931.68    1.118    0.120    0.500
     9         4      6.00    0.120   1.00  0.80    2.18      600.00     1341.61    1.610    0.120    0.500
    10         1      5.00    0.120                 2.49      600.00     1341.61    2.683    0.200    0.600
    11         1      6.00    0.120                 2.81      640.00     1526.46    3.053    0.200    0.533
    12         1     12.00    0.120                 3.33      640.00     1526.46    1.832    0.120    0.267
    13         1     10.00    0.120                 3.96      700.00     1826.09    2.191    0.120    0.350
    14         1     10.00    0.120                 4.54      750.00     2096.27    2.516    0.120    0.375
    15         1     10.00    0.120                 5.11      950.00     3363.35    6.727    0.200    0.475
    16         1     10.00    0.120                 5.69     1100.00     4509.32    9.019    0.200    0.550
    17         1     10.00    0.120                 6.27     1200.00     5366.46   10.733    0.200    0.600
    18         1     10.00    0.120                 6.84     1300.00     6298.14   12.596    0.200    0.650
    19         1     10.00    0.120                 7.42     1300.00     6298.14   12.596    0.200    0.650
    20         1     10.00    0.120                 7.99     1370.00     6994.66   13.989    0.200    0.685
    21         1     10.00    0.120                 8.57     1370.00     6994.66   13.989    0.200    0.685


 SHEAR WAVE VELOCITY IN BASE =  2500.
 UNIT WEIGHT OF BASE =   0.130


 ***********************************************************
   OUTPUT FOR IV02180
   WITH A PEAK ACCELERATION OF  0.36 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

     1       0.00    0.283    1.414    0.251    5.508    0.022    0.062    0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
     2       4.00    0.284    1.401    0.251    5.508    0.022    0.177    0.023  1.000  1.000  1.000  0.000  0.000   0.000    6.00
     3       8.00    0.290    1.394    0.250    5.508    0.022    0.285    0.037  1.000  1.000  1.000  0.000  0.000   0.000   10.00
     4      12.00    0.295    1.396    0.250    5.508    0.022    0.367    0.564  1.000  1.000  1.000  0.870  0.870   0.019   13.50
     5      15.00    0.302    1.318    0.234    5.498    0.053    0.450    2.120  1.000  1.000  1.000  1.000  1.000   0.079   16.50
     6      18.00    0.433    1.237    0.176    5.473   -0.015    0.540    1.509  1.000  1.000  1.000  0.994  0.994   0.031   20.00
     7      22.00    0.413    1.304    0.125   12.008   -0.015    0.609    0.687  1.000  1.000  1.000  0.893  0.893   0.020   24.00
```

```
     8      26.00    0.285    1.223    0.102    3.413   -0.047    0.698    0.224  1.000  1.000  1.000  0.013  0.013    0.008   28.50
     9      31.00    0.269    1.197    0.094    3.413   -0.053    0.810    0.117  1.000  1.000  1.000  0.014  0.014    0.006   34.00
    10      37.00    0.276    1.158    0.090    3.413   -0.056    0.924    0.123  1.000  1.000  1.000  0.000  0.000    0.000   39.50
    11      42.00    0.339    1.114    0.086    3.413   -0.055    1.024    0.118  1.000  1.000  1.000  0.000  0.000    0.000   45.00
    12      48.00    0.260    1.075    0.081    3.413   -0.051    1.185    0.271  1.000  1.000  1.000  0.000  0.000    0.000   54.00
    13      60.00    0.391    1.022    0.078   11.973   -0.025    1.252    0.196  1.000  1.000  1.000  0.000  0.000    0.000   65.00
    14      70.00    0.380    1.024    0.047   11.963   -0.034    1.452    0.167  1.000  1.000  1.000  0.000  0.000    0.000   75.00
    15      80.00    0.325    1.032    0.034   12.303   -0.018    1.656    0.067  1.000  1.000  1.000  0.000  0.000    0.000   85.00
    16      90.00    0.313    1.021    0.028   11.938   -0.008    1.841    0.054  1.000  1.000  1.000  0.000  0.000    0.000   95.00
    17     100.00    0.279    1.011    0.022   11.933   -0.007    2.037    0.048  1.000  1.000  1.000  0.000  0.000    0.000  105.00
    18     110.00    0.272    0.996    0.017    4.398   -0.005    2.204    0.043  1.000  1.000  1.000  0.000  0.000    0.000  115.00
    19     120.00    0.268    0.977    0.013   12.298   -0.004    2.323    0.046  1.000  1.000  1.000  0.000  0.000    0.000  125.00
    20     130.00    0.235    0.953    0.009   12.293   -0.001    2.430    0.042  1.000  1.000  1.000  0.000  0.000    0.000  135.00
    21     140.00    0.294    0.929    0.004   12.288   -0.001    2.540    0.044  1.000  1.000  1.000  0.000  0.000    0.000  145.00
   BASE    150.00    0.252    0.900    0.491                                                   GROUND SURFACE SETTLEMENT    0.164

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                        MIDLAYER

     1       0.00    0.311    1.543    0.585   25.116   -0.107    0.069    0.007  1.000  1.000  1.000  0.000  0.000    0.000    2.00
     2       4.00    0.277    1.542    0.585   25.116   -0.107    0.169    0.022  1.000  1.000  1.000  0.000  0.000    0.000    6.00
     3       8.00    0.284    1.533    0.584   25.116   -0.107    0.274    0.036  1.000  1.000  1.000  0.000  0.000    0.000   10.00
     4      12.00    0.278    1.518    0.584   25.116   -0.107    0.355    0.354  1.000  1.000  1.000  0.870  0.870    0.019   13.50
     5      15.00    0.272    1.452    0.576   25.116   -0.101    0.430    4.012  1.000  1.000  1.000  1.000  1.000    0.079   16.50
     6      18.00    0.324    1.402    0.310   25.056    0.041    0.513    3.168  1.000  1.000  1.000  0.994  0.994    0.031   20.00
     7      22.00    0.371    1.647    0.160    7.088    0.040    0.600    0.454  1.000  1.000  1.000  0.893  0.893    0.020   24.00
     8      26.00    0.319    1.550    0.129   26.096    0.096    0.695    0.231  1.000  1.000  1.000  0.013  0.013    0.008   28.50
     9      31.00    0.306    1.496    0.136   26.096    0.105    0.800    0.133  1.000  1.000  1.000  0.014  0.014    0.006   34.00
    10      37.00    0.330    1.446    0.133   26.091    0.105    0.893    0.124  1.000  1.000  1.000  0.000  0.000    0.000   39.50
    11      42.00    0.343    1.409    0.130   26.086    0.104    0.975    0.118  1.000  1.000  1.000  0.000  0.000    0.000   45.00
    12      48.00    0.306    1.356    0.127   26.086    0.103    1.138    0.262  1.000  1.000  1.000  0.000  0.000    0.000   54.00
    13      60.00    0.352    1.203    0.103   25.291    0.075    1.362    0.267  1.000  1.000  1.000  0.000  0.000    0.000   65.00
    14      70.00    0.355    1.192    0.061   11.693    0.035    1.578    0.258  1.000  1.000  1.000  0.000  0.000    0.000   75.00
    15      80.00    0.345    1.168    0.039   12.058   -0.003    1.769    0.079  1.000  1.000  1.000  0.000  0.000    0.000   85.00
```

```
     16      90.00    0.306    1.158    0.035   12.053   -0.005    1.966    0.060  1.000  1.000  1.000  0.000  0.000    0.000   95.00
     17     100.00    0.311    1.130    0.030   12.053   -0.004    2.154    0.055  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     18     110.00    0.271    1.116    0.026   12.053   -0.003    2.363    0.049  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     19     120.00    0.264    1.101    0.020   12.048   -0.002    2.621    0.052  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     20     130.00    0.300    1.089    0.013   12.043   -0.002    2.795    0.051  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     21     140.00    0.335    1.075    0.007   12.058   -0.001    2.921    0.054  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00    0.276    1.056    0.761                                           GROUND SURFACE SETTLEMENT    0.164

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  5
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  6
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  7


 *********************
  NEXT INPUT MOTION
 *********************


 **********************************************************
 THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
 IN ORDER TO MEET THE COURANT STABILITY CRITERION
 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
 **********************************************************


 ***********************************************************
   OUTPUT FOR IVEC4140
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.326    1.286    0.360    5.738   -0.063    0.072    0.008  1.000  1.000  1.000  0.000  0.000    0.000    2.00
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       2       4.00     0.313    1.258    0.360    5.738   -0.063    0.202    0.022  1.000  1.000  1.000  0.000  0.000    0.000    6.00
       3       8.00     0.306    1.229    0.359    5.738   -0.063    0.327    0.041  1.000  1.000  1.000  0.000  0.000    0.000   10.00
       4      12.00     0.311    1.223    0.358    5.738   -0.063    0.433    0.631  1.000  1.000  1.000  0.760  0.760    0.014   13.50
       5      15.00     0.284    1.159    0.331    5.723   -0.058    0.524    0.612  1.000  1.000  1.000  0.893  0.893    0.015   16.50
       6      18.00     0.290    1.227    0.313    5.718   -0.069    0.625    1.244  1.000  1.000  1.000  0.970  0.970    0.031   20.00
       7      22.00     0.279    1.316    0.279    5.703   -0.064    0.730    0.694  1.000  1.000  1.000  0.909  0.909    0.021   24.00
       8      26.00     0.269    1.289    0.249    5.683   -0.080    0.845    0.264  1.000  1.000  1.000  0.020  0.020    0.009   28.50
       9      31.00     0.237    1.266    0.229    5.673   -0.070    0.985    0.142  1.000  1.000  1.000  0.021  0.021    0.006   34.00
      10      37.00     0.245    1.231    0.217    5.668   -0.066    1.112    0.141  1.000  1.000  1.000  0.000  0.000    0.000   39.50
      11      42.00     0.261    1.200    0.208    5.663   -0.063    1.235    0.142  1.000  1.000  1.000  0.000  0.000    0.000   45.00
      12      48.00     0.240    1.176    0.197    5.663   -0.063    1.428    0.394  1.000  1.000  1.000  0.000  0.000    0.000   54.00
      13      60.00     0.334    1.158    0.133    5.583   -0.033    1.581    0.332  1.000  1.000  1.000  0.000  0.000    0.000   65.00
      14      70.00     0.317    1.099    0.086    5.553   -0.011    1.726    0.272  1.000  1.000  1.000  0.000  0.000    0.000   75.00
      15      80.00     0.377    1.036    0.048    5.498    0.004    1.935    0.084  1.000  1.000  1.000  0.000  0.000    0.000   85.00
      16      90.00     0.353    0.985    0.039    5.488    0.003    2.128    0.061  1.000  1.000  1.000  0.000  0.000    0.000   95.00
      17     100.00     0.336    0.945    0.032    5.483    0.005    2.371    0.059  1.000  1.000  1.000  0.000  0.000    0.000  105.00
      18     110.00     0.359    0.920    0.026    5.478    0.003    2.621    0.052  1.000  1.000  1.000  0.000  0.000    0.000  115.00
      19     120.00     0.327    0.907    0.021    5.473    0.002    2.860    0.060  1.000  1.000  1.000  0.000  0.000    0.000  125.00
      20     130.00     0.328    0.875    0.014    5.468    0.001    3.036    0.059  1.000  1.000  1.000  0.000  0.000    0.000  135.00
      21     140.00     0.317    0.860    0.007    5.473    0.000    3.184    0.060  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE     150.00     0.292    0.844    0.527                                                  GROUND SURFACE SETTLEMENT    0.095

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR IVEC4230
   WITH A PEAK ACCELERATION OF  0.40 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.    DEPTH      AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
             TO TOP                                                            GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

       1       0.00     0.326    1.864    0.283    5.773   -0.163    0.072    0.008  1.000  1.000  1.000  0.000  0.000    0.000    2.00
       2       4.00     0.310    1.852    0.283    5.773   -0.162    0.198    0.022  1.000  1.000  1.000  0.000  0.000    0.000    6.00
       3       8.00     0.315    1.822    0.283    5.773   -0.163    0.312    0.041  1.000  1.000  1.000  0.000  0.000    0.000   10.00
       4      12.00     0.299    1.794    0.282    5.773   -0.162    0.408    0.497  1.000  1.000  1.000  0.760  0.760    0.014   13.50
       5      15.00     0.283    1.688    0.265    5.773   -0.158    0.491    0.466  1.000  1.000  1.000  0.893  0.893    0.015   16.50
       6      18.00     0.286    1.660    0.249   12.028   -0.153    0.580    2.636  1.000  1.000  1.000  0.970  0.970    0.031   20.00
       7      22.00     0.368    1.636    0.213    5.773   -0.080    0.670    0.934  1.000  1.000  1.000  0.909  0.909    0.021   24.00
       8      26.00     0.308    1.599    0.178    5.773   -0.014    0.753    0.290  1.000  1.000  1.000  0.020  0.020    0.009   28.50
       9      31.00     0.298    1.560    0.161    5.773   -0.015    0.902    0.158  1.000  1.000  1.000  0.021  0.021    0.006   34.00
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    10      37.00    0.325    1.526    0.148    5.773   -0.018     1.067    0.140  1.000  1.000  1.000  0.000  0.000    0.000   39.50
    11      42.00    0.281    1.504    0.139    5.773   -0.018     1.228    0.141  1.000  1.000  1.000  0.000  0.000    0.000   45.00
    12      48.00    0.274    1.475    0.130    5.768   -0.017     1.460    0.336  1.000  1.000  1.000  0.000  0.000    0.000   54.00
    13      60.00    0.327    1.479    0.087    5.753   -0.024     1.653    0.276  1.000  1.000  1.000  0.000  0.000    0.000   65.00
    14      70.00    0.300    1.504    0.060    5.733   -0.016     1.818    0.237  1.000  1.000  1.000  0.000  0.000    0.000   75.00
    15      80.00    0.373    1.535    0.039    5.703   -0.008     2.027    0.089  1.000  1.000  1.000  0.000  0.000    0.000   85.00
    16      90.00    0.327    1.500    0.031    5.708   -0.004     2.196    0.063  1.000  1.000  1.000  0.000  0.000    0.000   95.00
    17     100.00    0.347    1.466    0.025    5.703   -0.003     2.401    0.054  1.000  1.000  1.000  0.000  0.000    0.000  105.00
    18     110.00    0.313    1.444    0.020    5.703   -0.002     2.632    0.050  1.000  1.000  1.000  0.000  0.000    0.000  115.00
    19     120.00    0.334    1.424    0.016    5.703   -0.001     2.805    0.055  1.000  1.000  1.000  0.000  0.000    0.000  125.00
    20     130.00    0.348    1.407    0.012    5.703    0.001     2.974    0.052  1.000  1.000  1.000  0.000  0.000    0.000  135.00
    21     140.00    0.294    1.394    0.006    5.698   -0.000     3.119    0.055  1.000  1.000  1.000  0.000  0.000    0.000  145.00
  BASE     150.00    0.272    1.382    0.850                                                 GROUND SURFACE SETTLEMENT   0.095

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  8
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  9
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 10
 HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 11

 FOR SECOND COMPONENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 12
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 13
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 14


*********************
  NEXT INPUT MOTION
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**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


***********************************************************
  OUTPUT FOR JOS000
  WITH A PEAK ACCELERATION OF  0.35 G
  AND SLOPE = 0.00
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******************************************************
  MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
******************************************************
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LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                           GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1      0.00    0.272    1.597    0.286    38.041    0.249    0.060     0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.264    1.585    0.286    38.041    0.249    0.160     0.019  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3      8.00    0.281    1.574    0.285    38.041    0.248    0.273     0.034  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4     12.00    0.257    1.577    0.285    38.041    0.249    0.344     1.960  1.000  1.000  1.000  0.997  0.997   0.024   13.50
      5     15.00    0.364    1.471    0.212    19.607    0.178    0.408     1.682  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6     18.00    0.358    1.434    0.161    10.503    0.084    0.481     1.455  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7     22.00    0.460    1.661    0.144    27.531   -0.065    0.550     0.601  1.000  1.000  1.000  0.929  0.929   0.026   24.00
      8     26.00    0.306    1.606    0.135    27.246   -0.087    0.618     0.150  1.000  1.000  1.000  0.002  0.002   0.007   28.50
      9     31.00    0.288    1.566    0.142    27.246   -0.096    0.739     0.094  1.000  1.000  1.000  0.003  0.003   0.006   34.00
     10     37.00    0.269    1.513    0.144    27.241   -0.100    0.849     0.101  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11     42.00    0.244    1.451    0.140    27.241   -0.098    0.944     0.096  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12     48.00    0.258    1.418    0.136    27.236   -0.097    1.038     0.185  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13     60.00    0.424    1.430    0.102    27.206   -0.071    1.258     0.191  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14     70.00    0.371    1.405    0.069    27.186   -0.042    1.392     0.171  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15     80.00    0.286    1.360    0.041    26.116   -0.015    1.501     0.061  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16     90.00    0.267    1.309    0.033    26.111   -0.011    1.676     0.049  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17    100.00    0.271    1.264    0.028    26.106   -0.009    1.818     0.042  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18    110.00    0.257    1.218    0.022    26.101   -0.005    1.923     0.038  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19    120.00    0.250    1.191    0.018    26.091   -0.005    2.014     0.040  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20    130.00    0.244    1.161    0.011    26.086   -0.003    2.111     0.037  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21    140.00    0.275    1.132    0.006    26.086   -0.002    2.224     0.039  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE   150.00    0.224    1.117    0.577                                                  GROUND SURFACE SETTLEMENT   0.245

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR JOS090
   WITH A PEAK ACCELERATION OF  0.39 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                           GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1      0.00    0.276    1.387    1.217    34.556   -0.923    0.061     0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.244    1.375    1.217    34.556   -0.923    0.160     0.018  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3      8.00    0.243    1.369    1.217    34.561   -0.923    0.258     0.030  1.000  1.000  1.000  0.000  0.000   0.000   10.00
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     4      12.00    0.263    1.364    1.216   34.561   -0.922    0.328    1.769  1.000  1.000  1.000  0.997  0.997   0.024   13.50
     5      15.00    0.375    1.315    1.069   34.556   -0.853    0.395    3.785  1.000  1.000  1.000  1.000  1.000   0.079   16.50
     6      18.00    0.399    1.409    0.668   34.561   -0.544    0.463    2.849  1.000  1.000  1.000  1.000  1.000   0.103   20.00
     7      22.00    0.389    1.410    0.274   10.038   -0.135    0.518    0.653  1.000  1.000  1.000  0.929  0.929   0.026   24.00
     8      26.00    0.314    1.442    0.228   10.003   -0.100    0.553    0.131  1.000  1.000  1.000  0.002  0.002   0.007   28.50
     9      31.00    0.291    1.386    0.207   10.003   -0.083    0.709    0.094  1.000  1.000  1.000  0.003  0.003   0.006   34.00
    10      37.00    0.287    1.362    0.194    9.998   -0.074    0.875    0.104  1.000  1.000  1.000  0.000  0.000   0.000   39.50
    11      42.00    0.268    1.340    0.183    9.993   -0.068    1.027    0.112  1.000  1.000  1.000  0.000  0.000   0.000   45.00
    12      48.00    0.266    1.319    0.173    9.988   -0.063    1.239    0.275  1.000  1.000  1.000  0.000  0.000   0.000   54.00
    13      60.00    0.325    1.262    0.126    9.948   -0.048    1.462    0.265  1.000  1.000  1.000  0.000  0.000   0.000   65.00
    14      70.00    0.324    1.232    0.086    9.918   -0.046    1.661    0.240  1.000  1.000  1.000  0.000  0.000   0.000   75.00
    15      80.00    0.400    1.219    0.049    9.873   -0.016    1.893    0.076  1.000  1.000  1.000  0.000  0.000   0.000   85.00
    16      90.00    0.351    1.205    0.040    9.868   -0.015    2.205    0.065  1.000  1.000  1.000  0.000  0.000   0.000   95.00
    17     100.00    0.319    1.192    0.033    9.863   -0.012    2.453    0.060  1.000  1.000  1.000  0.000  0.000   0.000  105.00
    18     110.00    0.304    1.169    0.026    9.853   -0.008    2.691    0.056  1.000  1.000  1.000  0.000  0.000   0.000  115.00
    19     120.00    0.293    1.152    0.020    9.848   -0.006    2.858    0.061  1.000  1.000  1.000  0.000  0.000   0.000  125.00
    20     130.00    0.286    1.149    0.013    9.848   -0.004    2.997    0.056  1.000  1.000  1.000  0.000  0.000   0.000  135.00
    21     140.00    0.289    1.137    0.006    9.848   -0.001    3.136    0.059  1.000  1.000  1.000  0.000  0.000   0.000  145.00
  BASE     150.00    0.290    1.126    0.543                                              GROUND SURFACE SETTLEMENT   0.245

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 15
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 16
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 17
 HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 18

 FOR SECOND COMPONENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 19
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 20
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 21


*********************
  NEXT INPUT MOTION
*********************


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
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***********************************************************
  OUTPUT FOR NIS000
  WITH A PEAK ACCELERATION OF  0.39 G
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   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX  UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.363    0.980    0.427   40.382   -0.231    0.080    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2       4.00    0.271    0.971    0.427   40.382   -0.231    0.195    0.024  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3       8.00    0.269    0.955    0.427   40.382   -0.231    0.258    0.033  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4      12.00    0.341    0.952    0.427   40.377   -0.232    0.326    0.900  1.000  1.000  1.000  0.902  0.902   0.020   13.50
      5      15.00    0.276    0.940    0.440   40.377   -0.249    0.405    3.050  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6      18.00    0.404    1.365    0.257   28.771   -0.118    0.465    2.244  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7      22.00    0.347    1.451    0.167    8.908    0.082    0.533    0.343  1.000  1.000  1.000  0.862  0.862   0.017   24.00
      8      26.00    0.350    1.424    0.141    8.908    0.081    0.617    0.160  1.000  1.000  1.000  0.005  0.005   0.007   28.50
      9      31.00    0.292    1.397    0.132    8.903    0.079    0.729    0.096  1.000  1.000  1.000  0.004  0.004   0.006   34.00
     10      37.00    0.308    1.347    0.125    8.903    0.077    0.840    0.095  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11      42.00    0.296    1.293    0.122    8.898    0.077    0.963    0.092  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12      48.00    0.249    1.235    0.116    8.888    0.076    1.140    0.191  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13      60.00    0.346    1.102    0.071    8.878    0.030    1.226    0.175  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14      70.00    0.316    1.026    0.046    8.873    0.018    1.354    0.150  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15      80.00    0.317    0.997    0.033   12.053    0.006    1.533    0.056  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16      90.00    0.270    0.969    0.028   12.053    0.005    1.700    0.043  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17     100.00    0.285    0.936    0.023   12.053    0.005    1.894    0.042  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18     110.00    0.299    0.911    0.018   12.053    0.004    2.063    0.038  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19     120.00    0.278    0.884    0.014   12.053    0.002    2.214    0.042  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20     130.00    0.263    0.842    0.008   12.048    0.002    2.318    0.039  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21     140.00    0.265    0.802    0.005   10.523    0.002    2.477    0.042  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE    150.00    0.251    0.781    0.522                                             GROUND SURFACE SETTLEMENT   0.232

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR NIS090
   WITH A PEAK ACCELERATION OF  0.36 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************
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LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1      0.00    0.343    1.341    0.634   18.277   -0.444    0.075    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.283    1.329    0.634   18.277   -0.444    0.184    0.018  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3      8.00    0.272    1.309    0.634   18.277   -0.445    0.267    0.034  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4     12.00    0.312    1.296    0.634   18.277   -0.445    0.359    0.683  1.000  1.000  1.000  0.902  0.902   0.020   13.50
      5     15.00    0.383    1.243    0.638   18.277   -0.448    0.425    4.074  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6     18.00    0.429    1.347    0.268   18.277   -0.191    0.492    2.750  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7     22.00    0.418    1.768    0.143   14.628    0.084    0.562    0.498  1.000  1.000  1.000  0.862  0.862   0.017   24.00
      8     26.00    0.345    1.684    0.129   14.628    0.073    0.628    0.142  1.000  1.000  1.000  0.005  0.005   0.007   28.50
      9     31.00    0.291    1.640    0.128   14.628    0.073    0.719    0.100  1.000  1.000  1.000  0.004  0.004   0.006   34.00
     10     37.00    0.343    1.612    0.127   14.628    0.074    0.835    0.105  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11     42.00    0.332    1.579    0.124   14.628    0.072    0.943    0.105  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12     48.00    0.279    1.534    0.117   14.643    0.068    1.108    0.226  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13     60.00    0.351    1.382    0.088   14.658    0.050    1.286    0.213  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14     70.00    0.358    1.274    0.055    8.358    0.020    1.459    0.194  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15     80.00    0.333    1.175    0.036   11.238    0.008    1.618    0.066  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16     90.00    0.308    1.157    0.027   11.238    0.007    1.773    0.050  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17    100.00    0.309    1.126    0.022   10.238    0.006    1.927    0.041  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18    110.00    0.340    1.103    0.016   11.233    0.005    2.113    0.040  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19    120.00    0.327    1.083    0.012    5.083    0.004    2.278    0.042  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20    130.00    0.322    1.079    0.008   11.228    0.002    2.370    0.041  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21    140.00    0.300    1.045    0.005   10.228   -0.000    2.497    0.043  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE   150.00    0.232    1.023    0.613                                                GROUND SURFACE SETTLEMENT   0.232

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 22
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 23
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 24
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 25

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 26
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 27
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 28


 *********************
   NEXT INPUT MOTION
 *********************


 **********************************************************
 THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
 IN ORDER TO MEET THE COURANT STABILITY CRITERION
 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
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 **********************************************************


 ***********************************************************
   OUTPUT FOR YAR060
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.297    1.490    0.496   31.030   -0.409    0.065    0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2       4.00    0.267    1.485    0.496   31.030   -0.409    0.166    0.019  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3       8.00    0.270    1.484    0.495   31.030   -0.409    0.274    0.034  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4      12.00    0.283    1.472    0.496   31.030   -0.410    0.364    0.581  1.000  1.000  1.000  0.881  0.881   0.019   13.50
      5      15.00    0.278    1.390    0.469   31.025   -0.384    0.437    3.195  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6      18.00    0.372    1.358    0.195   27.146   -0.110    0.515    1.300  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7      22.00    0.305    1.371    0.116   15.998    0.011    0.577    0.895  1.000  1.000  1.000  0.915  0.915   0.021   24.00
      8      26.00    0.326    1.371    0.100   15.968    0.068    0.662    0.131  1.000  1.000  1.000  0.010  0.010   0.008   28.50
      9      31.00    0.285    1.358    0.094   15.963    0.065    0.802    0.083  1.000  1.000  1.000  0.010  0.010   0.006   34.00
     10      37.00    0.265    1.336    0.092   15.958    0.063    0.923    0.093  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11      42.00    0.252    1.301    0.088   15.958    0.058    1.036    0.091  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12      48.00    0.234    1.260    0.081   15.953    0.052    1.192    0.183  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13      60.00    0.287    1.217    0.064   16.703    0.041    1.323    0.150  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14      70.00    0.340    1.192    0.045   16.693    0.028    1.506    0.129  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15      80.00    0.368    1.172    0.028   15.868    0.017    1.676    0.061  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16      90.00    0.360    1.160    0.023   15.863    0.015    1.869    0.048  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17     100.00    0.324    1.144    0.019   13.908    0.012    1.983    0.043  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18     110.00    0.327    1.131    0.015   13.903    0.010    2.061    0.038  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19     120.00    0.324    1.110    0.012   15.853    0.009    2.159    0.041  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20     130.00    0.328    1.104    0.009   13.893    0.005    2.288    0.039  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21     140.00    0.324    1.098    0.005   13.888    0.004    2.395    0.041  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE    150.00    0.319    1.086    0.537                                              GROUND SURFACE SETTLEMENT   0.236

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR YAR330
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************
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 *****************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 *****************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1      0.00    0.350    1.476    0.674   18.992    0.285    0.077    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.313    1.470    0.674   18.992    0.285    0.197    0.024  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3      8.00    0.308    1.463    0.674   18.992    0.285    0.312    0.041  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4     12.00    0.301    1.456    0.674   18.992    0.285    0.409    0.470  1.000  1.000  1.000  0.881  0.881   0.019   13.50
      5     15.00    0.277    1.401    0.641   18.987    0.254    0.501    4.035  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6     18.00    0.312    1.333    0.397   18.282    0.156    0.578    1.756  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7     22.00    0.366    1.237    0.246   14.288    0.199    0.665    0.624  1.000  1.000  1.000  0.915  0.915   0.021   24.00
      8     26.00    0.326    1.198    0.211   14.243    0.156    0.761    0.224  1.000  1.000  1.000  0.010  0.010   0.008   28.50
      9     31.00    0.275    1.178    0.200   14.238    0.145    0.862    0.114  1.000  1.000  1.000  0.010  0.010   0.006   34.00
     10     37.00    0.274    1.156    0.190   14.233    0.140    0.957    0.110  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11     42.00    0.250    1.138    0.183   14.228    0.137    1.048    0.103  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12     48.00    0.268    1.111    0.174   14.228    0.134    1.177    0.236  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13     60.00    0.365    1.055    0.127   17.793    0.102    1.280    0.209  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14     70.00    0.429    1.008    0.084   17.813    0.065    1.445    0.169  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15     80.00    0.451    0.964    0.047   14.173    0.032    1.732    0.068  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16     90.00    0.406    0.938    0.038   14.048    0.026    2.075    0.061  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17    100.00    0.385    0.901    0.032   14.043    0.021    2.364    0.057  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18    110.00    0.356    0.870    0.026   14.038    0.017    2.618    0.055  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19    120.00    0.328    0.869    0.021   14.033    0.014    2.842    0.061  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20    130.00    0.309    0.864    0.014   14.028    0.008    2.956    0.055  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21    140.00    0.309    0.854    0.008   14.028    0.006    3.023    0.058  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE   150.00    0.304    0.844    0.565                                                GROUND SURFACE SETTLEMENT   0.236

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 29
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 30
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 31
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 32

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 33
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 34
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 35


 *********************
   NEXT INPUT MOTION
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**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


***********************************************************
  OUTPUT FOR UC2000
  WITH A PEAK ACCELERATION OF  0.42 G
  AND SLOPE = 0.00
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******************************************************
  MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
            TO TOP                                                        GAMMAX  DELTA  DETAG  DETAU                        MIDLAYER

      1      0.00    0.251    1.410    0.429   10.598    0.013    0.055    0.007  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2      4.00    0.242    1.411    0.429   10.598    0.013    0.145    0.019  1.000  1.000  1.000  0.000  0.000    0.000    6.00
      3      8.00    0.248    1.405    0.429   10.598    0.013    0.237    0.032  1.000  1.000  1.000  0.000  0.000    0.000   10.00
      4     12.00    0.251    1.393    0.429   10.598    0.014    0.309    0.583  1.000  1.000  1.000  0.850  0.850    0.017   13.50
      5     15.00    0.315    1.378    0.399   10.598   -0.012    0.368    2.039  1.000  1.000  1.000  1.000  1.000    0.079   16.50
      6     18.00    0.396    1.265    0.312   10.593   -0.006    0.440    1.611  1.000  1.000  1.000  1.000  1.000    0.103   20.00
      7     22.00    0.378    1.334    0.201   10.593    0.011    0.513    0.842  1.000  1.000  1.000  0.949  0.949    0.025   24.00
      8     26.00    0.348    1.257    0.136   10.588    0.016    0.603    0.171  1.000  1.000  1.000  0.013  0.013    0.009   28.50
      9     31.00    0.278    1.233    0.125   10.588    0.009    0.714    0.098  1.000  1.000  1.000  0.011  0.011    0.006   34.00
     10     37.00    0.279    1.199    0.119   10.583    0.009    0.816    0.093  1.000  1.000  1.000  0.000  0.000    0.000   39.50
     11     42.00    0.299    1.158    0.116   10.583    0.012    0.905    0.091  1.000  1.000  1.000  0.000  0.000    0.000   45.00
     12     48.00    0.238    1.144    0.109   10.578    0.014    1.050    0.193  1.000  1.000  1.000  0.000  0.000    0.000   54.00
     13     60.00    0.319    1.094    0.085   10.283    0.021    1.293    0.166  1.000  1.000  1.000  0.000  0.000    0.000   65.00
     14     70.00    0.357    1.008    0.057   10.268    0.012    1.565    0.163  1.000  1.000  1.000  0.000  0.000    0.000   75.00
     15     80.00    0.407    0.999    0.036   10.248    0.006    1.789    0.065  1.000  1.000  1.000  0.000  0.000    0.000   85.00
     16     90.00    0.337    0.996    0.029   10.243    0.007    2.075    0.055  1.000  1.000  1.000  0.000  0.000    0.000   95.00
     17    100.00    0.292    0.997    0.022   10.238    0.005    2.286    0.051  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     18    110.00    0.282    0.989    0.018   10.233    0.004    2.407    0.043  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     19    120.00    0.272    0.972    0.013   10.233    0.003    2.497    0.047  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     20    130.00    0.285    0.944    0.008   10.223    0.003    2.564    0.040  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     21    140.00    0.282    0.929    0.004   10.238    0.002    2.617    0.043  1.000  1.000  1.000  0.000  0.000    0.000  145.00
   BASE    150.00    0.291    0.907    0.747                                             GROUND SURFACE SETTLEMENT    0.240

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT
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 ***********************************************************
   OUTPUT FOR UC2090
   WITH A PEAK ACCELERATION OF  0.34 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME     DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                     MIDLAYER

      1      0.00     0.300    1.466    0.647    18.412   -0.005    0.066    0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00     0.285    1.442    0.647    18.412   -0.005    0.179    0.022  1.000  1.000  1.000  0.000  0.000   0.000    6.00
      3      8.00     0.292    1.428    0.646    18.412   -0.005    0.287    0.037  1.000  1.000  1.000  0.000  0.000   0.000   10.00
      4     12.00     0.301    1.411    0.646    18.412   -0.005    0.388    0.533  1.000  1.000  1.000  0.850  0.850   0.017   13.50
      5     15.00     0.257    1.296    0.649    18.412    0.001    0.471    2.042  1.000  1.000  1.000  1.000  1.000   0.079   16.50
      6     18.00     0.399    1.204    0.425    18.407    0.050    0.566    4.373  1.000  1.000  1.000  1.000  1.000   0.103   20.00
      7     22.00     0.372    1.520    0.283    11.608   -0.138    0.660    0.882  1.000  1.000  1.000  0.949  0.949   0.025   24.00
      8     26.00     0.290    1.440    0.218    11.588   -0.081    0.762    0.245  1.000  1.000  1.000  0.013  0.013   0.009   28.50
      9     31.00     0.288    1.404    0.203    11.588   -0.068    0.863    0.131  1.000  1.000  1.000  0.011  0.011   0.006   34.00
     10     37.00     0.278    1.377    0.195    11.588   -0.062    1.019    0.120  1.000  1.000  1.000  0.000  0.000   0.000   39.50
     11     42.00     0.292    1.353    0.187    11.588   -0.058    1.151    0.116  1.000  1.000  1.000  0.000  0.000   0.000   45.00
     12     48.00     0.270    1.316    0.178    11.588   -0.054    1.252    0.213  1.000  1.000  1.000  0.000  0.000   0.000   54.00
     13     60.00     0.341    1.167    0.116    11.578   -0.024    1.425    0.209  1.000  1.000  1.000  0.000  0.000   0.000   65.00
     14     70.00     0.351    1.074    0.066    11.563    0.002    1.642    0.186  1.000  1.000  1.000  0.000  0.000   0.000   75.00
     15     80.00     0.312    1.047    0.038    11.523    0.002    1.762    0.066  1.000  1.000  1.000  0.000  0.000   0.000   85.00
     16     90.00     0.271    1.027    0.028    11.513    0.005    1.899    0.051  1.000  1.000  1.000  0.000  0.000   0.000   95.00
     17    100.00     0.286    0.999    0.023     4.708    0.004    2.074    0.048  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     18    110.00     0.288    0.979    0.018     4.698    0.003    2.217    0.043  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     19    120.00     0.305    0.968    0.014    10.378    0.001    2.384    0.046  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     20    130.00     0.240    0.944    0.010    10.373    0.000    2.544    0.043  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     21    140.00     0.255    0.921    0.005    10.373    0.001    2.640    0.046  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE   150.00     0.247    0.893    0.597                                                 GROUND SURFACE SETTLEMENT   0.240

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 36
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 37
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 38
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 39

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 40
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 41
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 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 42


*********************
  NEXT INPUT MOTION
*********************


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  2
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


***********************************************************
  OUTPUT FOR LOB000
  WITH A PEAK ACCELERATION OF  0.36 G
  AND SLOPE = 0.00
***********************************************************

******************************************************
  MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME     DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
            TO TOP                                                           GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.285    1.534    0.449   11.988   -0.040    0.063     0.007  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2       4.00    0.282    1.525    0.449   11.988   -0.040    0.177     0.021  1.000  1.000  1.000  0.000  0.000    0.000    6.00
      3       8.00    0.269    1.513    0.449   11.988   -0.040    0.280     0.038  1.000  1.000  1.000  0.000  0.000    0.000   10.00
      4      12.00    0.266    1.493    0.449   11.988   -0.039    0.377     0.444  1.000  1.000  1.000  0.831  0.831    0.015   13.50
      5      15.00    0.238    1.378    0.469   11.988   -0.023    0.454     2.439  1.000  1.000  1.000  1.000  1.000    0.079   16.50
      6      18.00    0.335    1.305    0.355   17.163    0.144    0.537     2.175  1.000  1.000  1.000  1.000  1.000    0.103   20.00
      7      22.00    0.338    1.352    0.180   17.163    0.131    0.616     0.940  1.000  1.000  1.000  0.963  0.963    0.024   24.00
      8      26.00    0.260    1.310    0.129    6.058    0.064    0.685     0.234  1.000  1.000  1.000  0.004  0.004    0.008   28.50
      9      31.00    0.265    1.299    0.128   11.843    0.068    0.777     0.125  1.000  1.000  1.000  0.004  0.004    0.006   34.00
     10      37.00    0.259    1.255    0.126   11.838    0.070    0.844     0.112  1.000  1.000  1.000  0.000  0.000    0.000   39.50
     11      42.00    0.277    1.199    0.125   11.833    0.071    0.976     0.108  1.000  1.000  1.000  0.000  0.000    0.000   45.00
     12      48.00    0.244    1.145    0.122   11.828    0.070    1.111     0.231  1.000  1.000  1.000  0.000  0.000    0.000   54.00
     13      60.00    0.279    1.095    0.091   11.813    0.048    1.220     0.176  1.000  1.000  1.000  0.000  0.000    0.000   65.00
     14      70.00    0.314    1.082    0.055   11.808    0.029    1.341     0.160  1.000  1.000  1.000  0.000  0.000    0.000   75.00
     15      80.00    0.349    1.046    0.035    6.003    0.016    1.474     0.059  1.000  1.000  1.000  0.000  0.000    0.000   85.00
     16      90.00    0.272    1.012    0.028    5.993    0.012    1.674     0.046  1.000  1.000  1.000  0.000  0.000    0.000   95.00
     17     100.00    0.306    0.987    0.024    5.988    0.009    1.889     0.042  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     18     110.00    0.289    0.962    0.019    5.988    0.008    1.976     0.039  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     19     120.00    0.265    0.938    0.014    5.983    0.006    2.092     0.041  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     20     130.00    0.306    0.907    0.010   11.778    0.005    2.325     0.039  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     21     140.00    0.322    0.882    0.006   11.778    0.003    2.379     0.042  1.000  1.000  1.000  0.000  0.000    0.000  145.00
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   BASE    150.00    0.245    0.858    0.577                                             GROUND SURFACE SETTLEMENT   0.236

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR LOB090
   WITH A PEAK ACCELERATION OF  0.38 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

     1       0.00    0.276    1.309    0.505    9.758    0.151    0.061    0.006  1.000  1.000  1.000  0.000  0.000   0.000    2.00
     2       4.00    0.245    1.304    0.505    9.758    0.151    0.150    0.018  1.000  1.000  1.000  0.000  0.000   0.000    6.00
     3       8.00    0.279    1.289    0.504    9.758    0.151    0.260    0.031  1.000  1.000  1.000  0.000  0.000   0.000   10.00
     4      12.00    0.245    1.276    0.504    9.758    0.150    0.333    0.295  1.000  1.000  1.000  0.831  0.831   0.015   13.50
     5      15.00    0.318    1.275    0.491    9.758    0.158    0.394    1.995  1.000  1.000  1.000  1.000  1.000   0.079   16.50
     6      18.00    0.323    1.161    0.398    9.748    0.121    0.453    2.849  1.000  1.000  1.000  1.000  1.000   0.103   20.00
     7      22.00    0.349    1.250    0.166    9.493   -0.032    0.491    0.650  1.000  1.000  1.000  0.963  0.963   0.024   24.00
     8      26.00    0.311    1.196    0.136    9.478   -0.035    0.538    0.138  1.000  1.000  1.000  0.004  0.004   0.008   28.50
     9      31.00    0.290    1.148    0.127    9.478   -0.031    0.649    0.090  1.000  1.000  1.000  0.004  0.004   0.006   34.00
    10      37.00    0.284    1.130    0.119    9.478   -0.028    0.755    0.096  1.000  1.000  1.000  0.000  0.000   0.000   39.50
    11      42.00    0.325    1.107    0.113    9.478   -0.025    0.864    0.094  1.000  1.000  1.000  0.000  0.000   0.000   45.00
    12      48.00    0.263    1.101    0.106    9.473   -0.022    1.122    0.199  1.000  1.000  1.000  0.000  0.000   0.000   54.00
    13      60.00    0.312    1.101    0.068    9.428   -0.006    1.291    0.146  1.000  1.000  1.000  0.000  0.000   0.000   65.00
    14      70.00    0.312    1.093    0.051    9.408   -0.009    1.447    0.143  1.000  1.000  1.000  0.000  0.000   0.000   75.00
    15      80.00    0.309    1.090    0.029    9.393    0.005    1.629    0.059  1.000  1.000  1.000  0.000  0.000   0.000   85.00
    16      90.00    0.283    1.074    0.025   15.538    0.007    1.794    0.046  1.000  1.000  1.000  0.000  0.000   0.000   95.00
    17     100.00    0.270    1.054    0.021   15.528    0.006    1.966    0.040  1.000  1.000  1.000  0.000  0.000   0.000  105.00
    18     110.00    0.262    1.036    0.016   15.523    0.004    2.091    0.037  1.000  1.000  1.000  0.000  0.000   0.000  115.00
    19     120.00    0.284    1.011    0.013   15.523    0.003    2.184    0.042  1.000  1.000  1.000  0.000  0.000   0.000  125.00
    20     130.00    0.269    0.978    0.009   15.518    0.002    2.242    0.037  1.000  1.000  1.000  0.000  0.000   0.000  135.00
    21     140.00    0.291    0.948    0.005   15.523    0.001    2.360    0.039  1.000  1.000  1.000  0.000  0.000   0.000  145.00
   BASE    150.00    0.274    0.917    0.742                                             GROUND SURFACE SETTLEMENT   0.236

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 43
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 44
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 45
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HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 46

FOR SECOND COMPONENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 47
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 48
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 49


**************************************
NORMAL TERMINATION FOR THIS INPUT FILE
**************************************
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**************************************************
**************************************************

 TESS2 - Version 3.00C
 Copyright 2020 Robert Pyke
 Built by rmp on 08/22/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: bh1bp


****************************************
130 Center Street  EB-1
****************************************
Under Basement  150-foot profile WITH PR
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS NOT INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


 FOR APPLIED WEIGHT WITHOUT PILES OR COLUMNS

 APPLIED WEIGHT PER UNIT AREA =    1.80

 LAYER NUMBER  REDUCTION FACTOR
      1             1.00
      2             0.98
      3             0.95
      4             0.90
      5             0.80
      6             1.00
      7             1.00
      8             1.00
      9             1.00
     10             1.00
     11             1.00
     12             1.00
     13             1.00
     14             1.00
```

```
     15              1.00
     16              1.00
     17              1.00


**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  1         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  2         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  3         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  4         0.02      1.00      0.00      0.00      0.00



PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E        SG        RG        ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G
     1       3      0.300       10         2.00         0.10         2.00
     2       3      0.300       10         2.00         0.10         2.00
     3       3      0.300       10         2.00         0.10         2.00
     4       4      0.600       10         2.00         0.10         2.00
     5       4      0.600       10         2.00         0.10         2.00


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR
      1      61    0.75
      2      62    0.75
      3      63    0.75
      4      70    0.50
      5      70    0.50
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```
PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3       1    1.00    0.50
      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   0.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0025 SECONDS

 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV        VS         GMAX        TAUMAX    GAMREF       TTR

     1       3        3.00     0.115   1.00  0.50   1.88       883.62      2788.53     4.183     0.150     0.736
     2       3        4.00     0.115   1.00  0.50   2.03       708.13      1790.89     2.686     0.150     0.443
     3       3        4.00     0.115   1.00  0.50   2.18       659.46      1553.17     2.330     0.150     0.412
     4       4        5.00     0.120   1.00  0.80   2.34       670.92      1677.51     2.013     0.120     0.335
     5       4        6.00     0.120   1.00  0.80   2.48       745.66      2072.10     2.487     0.120     0.311
     6       1        5.00     0.120                3.16       600.00      1341.61     2.683     0.200     0.300
     7       1        6.00     0.120                3.47       640.00      1526.46     3.053     0.200     0.267
     8       1       12.00     0.120                3.99       640.00      1526.46     1.832     0.120     0.133
     9       1       10.00     0.120                4.62       700.00      1826.09     2.191     0.120     0.175
    10       1       10.00     0.120                5.20       750.00      2096.27     2.516     0.120     0.187
    11       1       10.00     0.120                5.78       950.00      3363.35     6.727     0.200     0.237
    12       1       10.00     0.120                6.35      1100.00      4509.32     9.019     0.200     0.275
    13       1       10.00     0.120                6.93      1200.00      5366.46    10.733     0.200     0.300
    14       1       10.00     0.120                7.51      1300.00      6298.14    12.596     0.200     0.325
    15       1       10.00     0.120                8.08      1300.00      6298.14    12.596     0.200     0.325
    16       1       10.00     0.120                8.66      1370.00      6994.66    13.989     0.200     0.343
    17       1       10.00     0.120                9.23      1370.00      6994.66    13.989     0.200     0.343

SHEAR WAVE VELOCITY IN BASE =  2500.
UNIT WEIGHT OF BASE =   0.130


***********************************************************
  OUTPUT FOR IV02180
  WITH A PEAK ACCELERATION OF  0.36 G
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   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.162    1.145    0.362   26.280    0.174    0.466    0.017  1.000  1.000  1.000  0.111  0.111   0.000    1.50
      2       3.00    0.161    1.143    0.362   26.280    0.174    0.936    1.309  1.000  1.000  1.000  1.000  1.000   0.103    5.00
      3       7.00    0.963    1.399    0.337   26.260    0.201    1.001    3.301  1.000  1.000  1.000  1.000  1.000   0.101    9.00
      4      11.00    1.109    1.157    0.177    4.516    0.090    1.062    0.182  1.000  1.000  1.000  0.050  0.050   0.005   13.50
      5      16.00    0.655    1.151    0.177    4.514    0.091    1.154    0.120  1.000  1.000  1.000  0.050  0.050   0.005   19.00
      6      22.00    0.578    1.148    0.173    4.514    0.091    1.273    0.188  1.000  1.000  1.000  0.000  0.000   0.000   24.50
      7      27.00    0.497    1.131    0.163    4.511    0.082    1.336    0.162  1.000  1.000  1.000  0.000  0.000   0.000   30.00
      8      33.00    0.537    1.100    0.153    4.511    0.074    1.466    0.311  1.000  1.000  1.000  0.000  0.000   0.000   39.00
      9      45.00    0.405    1.011    0.108    4.489    0.036    1.666    0.234  1.000  1.000  1.000  0.000  0.000   0.000   50.00
     10      55.00    0.385    0.984    0.062    4.454    0.002    1.796    0.184  1.000  1.000  1.000  0.000  0.000   0.000   60.00
     11      65.00    0.349    0.959    0.033    2.496   -0.012    1.936    0.062  1.000  1.000  1.000  0.000  0.000   0.000   70.00
     12      75.00    0.320    0.962    0.027    2.494   -0.009    2.087    0.049  1.000  1.000  1.000  0.000  0.000   0.000   80.00
     13      85.00    0.297    0.960    0.022    2.491   -0.006    2.261    0.048  1.000  1.000  1.000  0.000  0.000   0.000   90.00
     14      95.00    0.260    0.950    0.017    2.489   -0.004    2.337    0.042  1.000  1.000  1.000  0.000  0.000   0.000  100.00
     15     105.00    0.258    0.943    0.013    2.484   -0.004    2.434    0.045  1.000  1.000  1.000  0.000  0.000   0.000  110.00
     16     115.00    0.287    0.929    0.008    4.901   -0.002    2.526    0.042  1.000  1.000  1.000  0.000  0.000   0.000  120.00
     17     125.00    0.293    0.909    0.005   12.293   -0.001    2.583    0.046  1.000  1.000  1.000  0.000  0.000   0.000  130.00
    BASE    135.00    0.261    0.889    0.492                                              GROUND SURFACE SETTLEMENT   0.214

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.172    1.304    0.579    8.644    0.128    0.493    0.019  1.000  1.000  1.000  0.111  0.111   0.000    1.50
```

```
    2      3.00    0.165    1.304    0.579    8.644    0.128    0.997    1.466  1.000  1.000  1.000  1.000  1.000    0.103    5.00
    3      7.00    0.556    1.238    0.468    8.629    0.164    1.044    6.338  1.000  1.000  1.000  1.000  1.000    0.101    9.00
    4     11.00    0.318    1.564    0.173   26.107    0.136    1.082    0.135  1.000  1.000  1.000  0.050  0.050    0.005   13.50
    5     16.00    0.310    1.547    0.170   26.107    0.133    1.132    0.100  1.000  1.000  1.000  0.050  0.050    0.005   19.00
    6     22.00    0.302    1.518    0.164   26.105    0.129    1.190    0.155  1.000  1.000  1.000  0.000  0.000    0.000   24.50
    7     27.00    0.278    1.461    0.161   26.105    0.128    1.239    0.127  1.000  1.000  1.000  0.000  0.000    0.000   30.00
    8     33.00    0.288    1.408    0.153   26.102    0.123    1.384    0.245  1.000  1.000  1.000  0.000  0.000    0.000   39.00
    9     45.00    0.355    1.270    0.114   26.080    0.092    1.613    0.194  1.000  1.000  1.000  0.000  0.000    0.000   50.00
   10     55.00    0.318    1.200    0.077   25.257    0.058    1.735    0.214  1.000  1.000  1.000  0.000  0.000    0.000   60.00
   11     65.00    0.370    1.149    0.043   11.666    0.015    1.833    0.075  1.000  1.000  1.000  0.000  0.000    0.000   70.00
   12     75.00    0.321    1.132    0.034   11.663    0.009    1.962    0.055  1.000  1.000  1.000  0.000  0.000    0.000   80.00
   13     85.00    0.303    1.121    0.025   11.658    0.002    2.199    0.052  1.000  1.000  1.000  0.000  0.000    0.000   90.00
   14     95.00    0.281    1.115    0.019   11.656    0.001    2.275    0.047  1.000  1.000  1.000  0.000  0.000    0.000  100.00
   15    105.00    0.252    1.109    0.015   24.932    0.000    2.447    0.051  1.000  1.000  1.000  0.000  0.000    0.000  110.00
   16    115.00    0.265    1.091    0.010   24.929   -0.001    2.620    0.049  1.000  1.000  1.000  0.000  0.000    0.000  120.00
   17    125.00    0.251    1.073    0.006   24.939   -0.001    2.774    0.052  1.000  1.000  1.000  0.000  0.000    0.000  130.00
  BASE   135.00    0.253    1.054    0.753                                               GROUND SURFACE SETTLEMENT    0.214

DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

FOR SECOND COMPONENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  5
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  6
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  7
```

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**************************************************
**************************************************

 TESS2 - Version 3.00C
 Copyright 2020 Robert Pyke
 Built by rmp on 08/22/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: bh1bd


****************************************
130 Center Street  EB-1  With R&D
****************************************
Under Basement  150-foot profile  WITH P
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


 FOR APPLIED WEIGHT WITHOUT PILES OR COLUMNS

 APPLIED WEIGHT PER UNIT AREA =    1.80

 LAYER NUMBER  REDUCTION FACTOR
      1              1.00
      2              0.98
      3              0.95
      4              0.90
      5              0.80
      6              1.00
      7              1.00
      8              1.00
      9              1.00
     10              1.00
     11              1.00
     12              1.00
     13              1.00
     14              1.00
```

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     15              1.00
     16              1.00
     17              1.00


**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  1         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  2         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  3         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  4         0.02      1.00      0.00      0.00      0.00



PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E        SG       RG        ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G
     1       3       0.200       10         2.00         0.10         2.00
     2       3       0.200       10         2.00         0.10         2.00
     3       3       0.200       10         2.00         0.10         2.00
     4       4       0.400       10         2.00         0.10         2.00
     5       4       0.400       10         2.00         0.10         2.00


VALUES FOR CONSOLIDATION PROPERTIES

 LAYER NO.      MV       K
     1      0.179E-03   0.328E-06
     2      0.279E-03   0.328E-06
     3      0.322E-03   0.328E-07
     4      0.298E-03   0.328E-05
     5      0.241E-03   0.328E-04
     6      0.373E-03   0.328E-08
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     7      0.328E-03   0.328E-08
     8      0.328E-03   0.328E-08
     9      0.274E-03   0.328E-08
    10      0.239E-03   0.328E-08
    11      0.149E-03   0.328E-08
    12      0.111E-03   0.328E-08
    13      0.932E-04   0.328E-08
    14      0.794E-04   0.328E-08
    15      0.794E-04   0.328E-08
    16      0.715E-04   0.328E-08
    17      0.715E-04   0.328E-08


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR
      1      61    0.75
      2      62    0.75
      3      63    0.75
      4      70    0.50
      5      70    0.50


PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3       1    1.00    0.50
      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   0.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0025 SECONDS

 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV        VS         GMAX        TAUMAX    GAMREF      TTR

     1       3        3.00     0.115   1.00  0.50   1.88       883.62      2788.53     4.183     0.150     0.736
     2       3        4.00     0.115   1.00  0.50   2.03       708.13      1790.89     2.686     0.150     0.443
     3       3        4.00     0.115   1.00  0.50   2.18       659.46      1553.17     2.330     0.150     0.412
     4       4        5.00     0.120   1.00  0.80   2.34       670.92      1677.51     2.013     0.120     0.335
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      5       4        6.00     0.120   1.00  0.80   2.48       745.66      2072.10     2.487     0.120     0.311
      6       1        5.00     0.120                3.16       600.00      1341.61     2.683     0.200     0.300
      7       1        6.00     0.120                3.47       640.00      1526.46     3.053     0.200     0.267
      8       1       12.00     0.120                3.99       640.00      1526.46     1.832     0.120     0.133
      9       1       10.00     0.120                4.62       700.00      1826.09     2.191     0.120     0.175
     10       1       10.00     0.120                5.20       750.00      2096.27     2.516     0.120     0.187
     11       1       10.00     0.120                5.78       950.00      3363.35     6.727     0.200     0.237
     12       1       10.00     0.120                6.35      1100.00      4509.32     9.019     0.200     0.275
     13       1       10.00     0.120                6.93      1200.00      5366.46    10.733     0.200     0.300
     14       1       10.00     0.120                7.51      1300.00      6298.14    12.596     0.200     0.325
     15       1       10.00     0.120                8.08      1300.00      6298.14    12.596     0.200     0.325
     16       1       10.00     0.120                8.66      1370.00      6994.66    13.989     0.200     0.343
     17       1       10.00     0.120                9.23      1370.00      6994.66    13.989     0.200     0.343


 SHEAR WAVE VELOCITY IN BASE =  2500.
 UNIT WEIGHT OF BASE =   0.130
 BASE IS IMPERMEABLE


 ***********************************************************
   OUTPUT FOR IV02180
   WITH A PEAK ACCELERATION OF  0.36 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME     DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE  DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.130    1.045    0.254   26.285    0.075    0.373    0.017  1.000  1.000  1.000  0.339  0.339   0.000    1.50
      2       3.00    0.127    1.044    0.254   26.285    0.075    0.756    1.279  1.000  1.000  1.000  1.000  1.000   0.103    5.00
      3       7.00    0.388    0.969    0.220   26.267    0.120    0.773    3.534  1.000  1.000  1.000  1.000  1.000   0.101    9.00
      4      11.00    0.387    1.159    0.120    4.514    0.015    0.824    0.133  1.000  1.000  1.000  0.250  0.250   0.004   13.50
      5      16.00    0.360    1.155    0.109    4.514    0.006    0.932    0.086  1.000  1.000  1.000  0.269  0.256   0.005   19.00
      6      22.00    0.367    1.143    0.104    4.511    0.002    1.053    0.120  1.000  1.000  1.000  0.000  0.000   0.000   24.50
      7      27.00    0.359    1.123    0.099    4.511   -0.001    1.131    0.111  1.000  1.000  1.000  0.000  0.000   0.000   30.00
      8      33.00    0.323    1.095    0.093    4.509   -0.004    1.160    0.201  1.000  1.000  1.000  0.000  0.000   0.000   39.00
      9      45.00    0.382    1.003    0.060    4.484   -0.028    1.335    0.177  1.000  1.000  1.000  0.000  0.000   0.000   50.00
     10      55.00    0.330    0.994    0.046    4.446   -0.025    1.473    0.140  1.000  1.000  1.000  0.000  0.000   0.000   60.00
     11      65.00    0.340    0.966    0.035   12.296   -0.020    1.603    0.058  1.000  1.000  1.000  0.000  0.000   0.000   70.00
     12      75.00    0.324    0.969    0.027   12.296   -0.014    1.763    0.047  1.000  1.000  1.000  0.000  0.000   0.000   80.00
     13      85.00    0.296    0.971    0.021   12.293   -0.010    1.917    0.044  1.000  1.000  1.000  0.000  0.000   0.000   90.00
     14      95.00    0.253    0.963    0.017   12.293   -0.007    2.074    0.040  1.000  1.000  1.000  0.000  0.000   0.000  100.00
     15     105.00    0.261    0.952    0.013   12.293   -0.005    2.178    0.044  1.000  1.000  1.000  0.000  0.000   0.000  110.00
     16     115.00    0.293    0.933    0.008    5.259   -0.002    2.261    0.041  1.000  1.000  1.000  0.000  0.000   0.000  120.00
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    17     125.00    0.316    0.908    0.005   12.293   -0.002    2.385    0.043  1.000  1.000  1.000  0.000  0.000    0.000  130.00
   BASE    135.00    0.262    0.885    0.492                                                 GROUND SURFACE SETTLEMENT   0.214

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

     1       0.00    0.129    1.313    0.670   27.453    0.515    0.372    0.015  1.000  1.000  1.000  0.339  0.339    0.000    1.50
     2       3.00    0.127    1.312    0.670   27.453    0.515    0.750    1.707  1.000  1.000  1.000  1.000  1.000    0.103    5.00
     3       7.00    0.869    1.298    0.752   39.544    0.654    0.788    6.716  1.000  1.000  1.000  1.000  1.000    0.101    9.00
     4      11.00    0.805    1.580    0.187   26.105    0.157    0.857    0.093  1.000  1.000  1.000  0.250  0.250    0.004   13.50
     5      16.00    0.375    1.558    0.187   26.105    0.159    0.940    0.093  1.000  1.000  1.000  0.269  0.256    0.005   19.00
     6      22.00    0.445    1.517    0.182   26.102    0.154    1.050    0.137  1.000  1.000  1.000  0.000  0.000    0.000   24.50
     7      27.00    0.314    1.463    0.176   26.102    0.150    1.182    0.131  1.000  1.000  1.000  0.000  0.000    0.000   30.00
     8      33.00    0.279    1.420    0.166   26.102    0.143    1.362    0.233  1.000  1.000  1.000  0.000  0.000    0.000   39.00
     9      45.00    0.348    1.267    0.111   26.077    0.097    1.418    0.194  1.000  1.000  1.000  0.000  0.000    0.000   50.00
    10      55.00    0.329    1.210    0.080   25.260    0.059    1.602    0.208  1.000  1.000  1.000  0.000  0.000    0.000   60.00
    11      65.00    0.351    1.167    0.040   11.668    0.016    1.822    0.075  1.000  1.000  1.000  0.000  0.000    0.000   70.00
    12      75.00    0.329    1.120    0.032   11.663    0.009    1.980    0.058  1.000  1.000  1.000  0.000  0.000    0.000   80.00
    13      85.00    0.298    1.104    0.025   11.661    0.006    2.111    0.053  1.000  1.000  1.000  0.000  0.000    0.000   90.00
    14      95.00    0.280    1.096    0.020   11.656    0.005    2.274    0.047  1.000  1.000  1.000  0.000  0.000    0.000  100.00
    15     105.00    0.284    1.102    0.014   11.651    0.002    2.438    0.050  1.000  1.000  1.000  0.000  0.000    0.000  110.00
    16     115.00    0.280    1.096    0.011   11.648    0.002    2.604    0.048  1.000  1.000  1.000  0.000  0.000    0.000  120.00
    17     125.00    0.283    1.077    0.005   11.648   -0.001    2.767    0.052  1.000  1.000  1.000  0.000  0.000    0.000  130.00
   BASE    135.00    0.255    1.056    0.738                                                 GROUND SURFACE SETTLEMENT   0.214

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

  FOR SECOND COMPONENT
```

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**************************************************
**************************************************

 TESS2 - Version 3.00C
 Copyright 2020 Robert Pyke
 Built by rmp on 08/22/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: BH1BPI


****************************************
130 Center Street  EB-1  LIQ SUPPRESSED
****************************************
Under Basement  150-foot profile WITH PR
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS NOT INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


 FOR APPLIED WEIGHT WITHOUT PILES OR COLUMNS

 APPLIED WEIGHT PER UNIT AREA =    1.80

 LAYER NUMBER  REDUCTION FACTOR
      1             1.00
      2             0.98
      3             0.95
      4             0.90
      5             0.80
      6             1.00
      7             1.00
      8             1.00
      9             1.00
     10             1.00
     11             1.00
     12             1.00
     13             1.00
     14             1.00
```

```
     15              1.00
     16              1.00
     17              1.00


**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE         VT     ALPHA      GMRP      TSTR      FSTR
  1          0.02      1.00      0.00      0.00      0.00

 MTYPE         VT     ALPHA      GMRP      TSTR      FSTR
  2          0.02      1.00      0.00      0.00      0.00

 MTYPE         VT     ALPHA      GMRP      TSTR      FSTR
  3          0.02      1.00      0.00      0.00      0.00

 MTYPE         VT     ALPHA      GMRP      TSTR      FSTR
  4          0.02      1.00      0.00      0.00      0.00



PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E        SG        RG        ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G
     1       3       0.800       10         2.00         0.10         2.00
     2       3       0.800       10         2.00         0.10         2.00
     3       3       0.800       10         2.00         0.10         2.00
     4       4       0.800       10         2.00         0.10         2.00
     5       4       0.800       10         2.00         0.10         2.00


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR
      1      61    0.75
      2      62    0.75
      3      63    0.75
      4      70    0.50
      5      70    0.50
```

```
PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3       1    1.00    0.50
      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   0.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0025 SECONDS

 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV        VS         GMAX        TAUMAX    GAMREF      TTR

     1       3        3.00     0.115   1.00  0.50   1.88       883.62      2788.53     4.183     0.150     0.736
     2       3        4.00     0.115   1.00  0.50   2.03       708.13      1790.89     2.686     0.150     0.443
     3       3        4.00     0.115   1.00  0.50   2.18       659.46      1553.17     2.330     0.150     0.412
     4       4        5.00     0.120   1.00  0.80   2.34       670.92      1677.51     2.013     0.120     0.335
     5       4        6.00     0.120   1.00  0.80   2.48       745.66      2072.10     2.487     0.120     0.311
     6       1        5.00     0.120                3.16       600.00      1341.61     2.683     0.200     0.300
     7       1        6.00     0.120                3.47       640.00      1526.46     3.053     0.200     0.267
     8       1       12.00     0.120                3.99       640.00      1526.46     1.832     0.120     0.133
     9       1       10.00     0.120                4.62       700.00      1826.09     2.191     0.120     0.175
    10       1       10.00     0.120                5.20       750.00      2096.27     2.516     0.120     0.187
    11       1       10.00     0.120                5.78       950.00      3363.35     6.727     0.200     0.237
    12       1       10.00     0.120                6.35      1100.00      4509.32     9.019     0.200     0.275
    13       1       10.00     0.120                6.93      1200.00      5366.46    10.733     0.200     0.300
    14       1       10.00     0.120                7.51      1300.00      6298.14    12.596     0.200     0.325
    15       1       10.00     0.120                8.08      1300.00      6298.14    12.596     0.200     0.325
    16       1       10.00     0.120                8.66      1370.00      6994.66    13.989     0.200     0.343
    17       1       10.00     0.120                9.23      1370.00      6994.66    13.989     0.200     0.343

SHEAR WAVE VELOCITY IN BASE =  2500.
UNIT WEIGHT OF BASE =   0.130


***********************************************************
  OUTPUT FOR IV02180
  WITH A PEAK ACCELERATION OF  0.36 G
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   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.181    1.255    0.263    6.101    0.021    0.520    0.020  1.000  1.000  1.000  0.000  0.000   0.001    1.50
      2       3.00    0.192    1.251    0.262    6.101    0.021    1.046    0.083  1.000  1.000  1.000  0.022  0.022   0.006    5.00
      3       7.00    0.438    1.224    0.261    6.101    0.020    1.106    0.128  1.000  1.000  1.000  0.022  0.022   0.008    9.00
      4      11.00    0.376    1.178    0.258    6.101    0.017    1.164    0.155  1.000  1.000  1.000  0.017  0.017   0.007   13.50
      5      16.00    0.375    1.162    0.254    6.101    0.019    1.255    0.109  1.000  1.000  1.000  0.017  0.017   0.007   19.00
      6      22.00    0.570    1.154    0.246    6.101    0.017    1.338    0.211  1.000  1.000  1.000  0.000  0.000   0.000   24.50
      7      27.00    0.380    1.137    0.238    6.099    0.018    1.419    0.167  1.000  1.000  1.000  0.000  0.000   0.000   30.00
      8      33.00    0.368    1.119    0.233    6.101    0.026    1.591    0.350  1.000  1.000  1.000  0.000  0.000   0.000   39.00
      9      45.00    0.392    1.030    0.167    6.101    0.035    1.800    0.267  1.000  1.000  1.000  0.000  0.000   0.000   50.00
     10      55.00    0.383    1.052    0.099    6.094    0.028    1.975    0.199  1.000  1.000  1.000  0.000  0.000   0.000   60.00
     11      65.00    0.351    1.049    0.043    4.404    0.004    2.135    0.082  1.000  1.000  1.000  0.000  0.000   0.000   70.00
     12      75.00    0.305    1.031    0.035    4.399    0.003    2.339    0.058  1.000  1.000  1.000  0.000  0.000   0.000   80.00
     13      85.00    0.279    1.012    0.029    4.396    0.002    2.536    0.052  1.000  1.000  1.000  0.000  0.000   0.000   90.00
     14      95.00    0.274    0.990    0.023    4.394   -0.000    2.690    0.052  1.000  1.000  1.000  0.000  0.000   0.000  100.00
     15     105.00    0.250    0.965    0.018    4.394   -0.001    2.847    0.055  1.000  1.000  1.000  0.000  0.000   0.000  110.00
     16     115.00    0.283    0.942    0.012    4.389    0.001    3.055    0.051  1.000  1.000  1.000  0.000  0.000   0.000  120.00
     17     125.00    0.318    0.934    0.007    4.396    0.000    3.237    0.058  1.000  1.000  1.000  0.000  0.000   0.000  130.00
    BASE    135.00    0.253    0.949    0.488                                              GROUND SURFACE SETTLEMENT   0.029

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.177    1.297    0.175   11.871    0.037    0.509    0.020  1.000  1.000  1.000  0.000  0.000   0.001    1.50
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    2      3.00    0.169    1.290    0.175   11.871    0.037    1.006    0.102  1.000  1.000  1.000  0.022  0.022   0.006    5.00
    3      7.00    0.396    1.249    0.170   11.873    0.035    1.060    0.124  1.000  1.000  1.000  0.022  0.022   0.008    9.00
    4     11.00    0.390    1.199    0.170   11.883    0.038    1.098    0.159  1.000  1.000  1.000  0.017  0.017   0.007   13.50
    5     16.00    0.348    1.129    0.167   11.896    0.033    1.178    0.112  1.000  1.000  1.000  0.017  0.017   0.007   19.00
    6     22.00    0.331    1.086    0.165   11.916    0.033    1.242    0.199  1.000  1.000  1.000  0.000  0.000   0.000   24.50
    7     27.00    0.313    1.090    0.158   11.926    0.028    1.315    0.168  1.000  1.000  1.000  0.000  0.000   0.000   30.00
    8     33.00    0.294    1.098    0.153   11.928    0.024    1.405    0.518  1.000  1.000  1.000  0.000  0.000   0.000   39.00
    9     45.00    0.400    1.163    0.091   11.928    0.036    1.649    0.250  1.000  1.000  1.000  0.000  0.000   0.000   50.00
   10     55.00    0.320    1.188    0.059   11.926    0.019    1.893    0.191  1.000  1.000  1.000  0.000  0.000   0.000   60.00
   11     65.00    0.361    1.210    0.031    2.989    0.004    2.028    0.077  1.000  1.000  1.000  0.000  0.000   0.000   70.00
   12     75.00    0.316    1.206    0.029   24.889   -0.001    2.182    0.060  1.000  1.000  1.000  0.000  0.000   0.000   80.00
   13     85.00    0.298    1.194    0.022   24.882    0.002    2.281    0.054  1.000  1.000  1.000  0.000  0.000   0.000   90.00
   14     95.00    0.311    1.175    0.018   24.877    0.002    2.307    0.044  1.000  1.000  1.000  0.000  0.000   0.000  100.00
   15    105.00    0.298    1.161    0.015   24.877    0.002    2.316    0.042  1.000  1.000  1.000  0.000  0.000   0.000  110.00
   16    115.00    0.303    1.141    0.011   24.874   -0.000    2.373    0.041  1.000  1.000  1.000  0.000  0.000   0.000  120.00
   17    125.00    0.271    1.121    0.006   24.874    0.001    2.442    0.045  1.000  1.000  1.000  0.000  0.000   0.000  130.00
  BASE   135.00    0.255    1.096    0.754                                              GROUND SURFACE SETTLEMENT   0.029

DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

FOR SECOND COMPONENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  5
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  6
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  7
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**************************************************
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 TESS2 - Version 3.00A
 Copyright 2020 Robert Pyke
 Built by rmp on 07/26/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: bh2


****************************************
130 Center Street  EB-2
****************************************
Free-field  150-foot profile
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS NOT INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  1         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  2         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  3         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  4         0.02      1.00      0.00      0.00      0.00
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PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E        SG        RG        ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR


PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3       1    1.00    0.50
      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   5.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0025 SECONDS

 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV        VS         GMAX        TAUMAX    GAMREF      TTR

     1       1        4.00     0.110                0.22       530.00       959.60     1.919     0.200     0.331
     2       2        4.00     0.110                0.69       410.00       574.25     1.436     0.250     0.256
     3       2        4.00     0.110                0.88       410.00       574.25     1.436     0.250     0.256
     4       2        3.00     0.110                1.05       410.00       574.25     1.436     0.250     0.342
     5       2        5.00     0.110                1.24       480.00       787.08     1.968     0.250     0.240
     6       2        5.00     0.110                1.48       450.00       691.77     1.384     0.200     0.225
     7       2        5.00     0.110                1.72       420.00       602.61     1.205     0.200     0.210
     8       1        5.00     0.120                1.98       530.00      1046.83     2.094     0.200     0.265
     9       1        5.00     0.120                2.27       550.00      1127.33     2.255     0.200     0.275
    10       1        5.00     0.120                2.56       590.00      1297.27     2.595     0.200     0.295
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    11       1        5.00     0.120                2.84       705.00      1852.27     2.778     0.150      0.352
    12       1        5.00     0.120                3.13       635.00      1502.70     2.254     0.150      0.317
    13       1        5.00     0.120                3.42       670.00      1672.92     2.509     0.150      0.335
    14       1        5.00     0.120                3.71       780.00      2267.33     4.535     0.200      0.390
    15       1        5.00     0.120                4.00       656.00      1603.74     3.207     0.200      0.328
    16       1        5.00     0.120                4.28       706.00      1857.53     3.715     0.200      0.353
    17       1        5.00     0.120                4.57       833.00      2585.92     5.172     0.200      0.417
    18       1        5.00     0.120                4.86       977.00      3557.25     7.115     0.200      0.488
    19       1        5.00     0.120                5.15       855.00      2724.32     5.449     0.200      0.427
    20       1        5.00     0.120                5.44      1016.00      3846.92     7.694     0.200      0.508
    21       1        5.00     0.120                5.72      1287.00      6172.80    12.346     0.200      0.643
    22       1       10.00     0.120                6.16      1300.00      6298.14    12.596     0.200      0.325
    23       1       10.00     0.120                6.73      1300.00      6298.14    12.596     0.200      0.325
    24       1       10.00     0.120                7.31      1300.00      6298.14    12.596     0.200      0.325
    25       1       10.00     0.120                7.88      1370.00      6994.66    13.989     0.200      0.343
    26       1       10.00     0.120                8.46      1370.00      6994.66    13.989     0.200      0.343


 SHEAR WAVE VELOCITY IN BASE =  2500.
 UNIT WEIGHT OF BASE =   0.130


 ***********************************************************
   OUTPUT FOR IV02180
   WITH A PEAK ACCELERATION OF  0.36 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                        MIDLAYER

      1      0.00    0.358    1.692    0.191   12.091    0.043    0.079    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.354    1.689    0.191   12.091    0.043    0.231    0.049  0.956  0.956  0.956  0.000  0.000   0.000    6.00
      3      8.00    0.348    1.660    0.190   12.091    0.042    0.374    0.094  0.936  0.935  0.935  0.000  0.000   0.000   10.00
      4     12.00    0.360    1.584    0.187   12.091    0.040    0.483    0.154  0.918  0.917  0.917  0.000  0.000   0.000   13.50
      5     15.00    0.334    1.509    0.185   12.088    0.041    0.593    0.127  0.926  0.926  0.926  0.000  0.000   0.000   17.50
      6     20.00    0.304    1.429    0.182   12.088    0.044    0.712    0.281  0.888  0.887  0.887  0.000  0.000   0.000   22.50
      7     25.00    0.336    1.391    0.170   12.078    0.048    0.805    0.643  0.829  0.828  0.828  0.000  0.000   0.000   27.50
      8     30.00    0.439    1.352    0.167   12.058    0.080    0.911    0.184  1.000  1.000  1.000  0.000  0.000   0.000   32.50
      9     35.00    0.352    1.315    0.157   12.053    0.081    1.029    0.202  1.000  1.000  1.000  0.000  0.000   0.000   37.50
     10     40.00    0.336    1.259    0.142   12.046    0.075    1.137    0.193  1.000  1.000  1.000  0.000  0.000   0.000   42.50
     11     45.00    0.309    1.193    0.123   12.038    0.065    1.252    0.147  1.000  1.000  1.000  0.000  0.000   0.000   47.50
     12     50.00    0.347    1.143    0.109   12.031    0.056    1.349    0.270  1.000  1.000  1.000  0.000  0.000   0.000   52.50
     13     55.00    0.389    1.081    0.083   15.745    0.036    1.421    0.235  1.000  1.000  1.000  0.000  0.000   0.000   57.50
     14     60.00    0.320    1.045    0.064   11.993    0.026    1.435    0.110  1.000  1.000  1.000  0.000  0.000   0.000   62.50
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     15      65.00      0.323     1.015     0.056     5.854     0.022     1.526     0.217  1.000  1.000  1.000  0.000  0.000    0.000   67.50
     16      70.00      0.349     0.979     0.054     5.431     0.011     1.651     0.165  1.000  1.000  1.000  0.000  0.000    0.000   72.50
     17      75.00      0.392     0.938     0.045     5.426     0.009     1.782     0.100  1.000  1.000  1.000  0.000  0.000    0.000   77.50
     18      80.00      0.377     0.904     0.038     5.424     0.009     1.932     0.068  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00      0.343     0.904     0.034     5.424     0.009     2.016     0.098  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00      0.306     0.924     0.030     5.419     0.004     2.126     0.066  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00      0.379     0.937     0.027     5.419     0.002     2.316     0.040  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00      0.282     0.944     0.025     5.416     0.002     2.408     0.041  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00      0.285     0.955     0.020     5.414     0.003     2.611     0.048  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00      0.254     0.967     0.016     5.414     0.002     2.778     0.052  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00      0.245     0.973     0.010     5.411     0.003     2.898     0.048  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00      0.267     0.976     0.005     5.411     0.001     2.991     0.052  1.000  1.000  1.000  0.000  0.000    0.000  145.00
   BASE     150.00      0.231     0.973     0.495                                                GROUND SURFACE SETTLEMENT    0.000

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH      AMAX      VMAX      DMAXR     TIME     DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                              GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00      0.330     1.661     0.252     5.806     0.138     0.073     0.008  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2       4.00      0.329     1.651     0.252     5.806     0.138     0.216     0.048  0.953  0.952  0.952  0.000  0.000    0.000    6.00
      3       8.00      0.329     1.590     0.250     5.804     0.136     0.351     0.106  0.931  0.930  0.930  0.000  0.000    0.000   10.00
      4      12.00      0.337     1.520     0.244     5.801     0.138     0.463     0.160  0.913  0.911  0.911  0.000  0.000    0.000   13.50
      5      15.00      0.314     1.435     0.238     5.799     0.139     0.584     0.153  0.923  0.921  0.921  0.000  0.000    0.000   17.50
      6      20.00      0.330     1.380     0.231     5.794     0.139     0.718     0.345  0.885  0.877  0.877  0.000  0.000    0.000   22.50
      7      25.00      0.310     1.415     0.201     5.779     0.133     0.835     1.195  0.793  0.782  0.782  0.000  0.000    0.000   27.50
      8      30.00      0.433     1.435     0.139     5.729     0.032     0.939     0.203  1.000  1.000  1.000  0.000  0.000    0.000   32.50
      9      35.00      0.366     1.432     0.126     5.716     0.024     1.067     0.221  1.000  1.000  1.000  0.000  0.000    0.000   37.50
     10      40.00      0.307     1.412     0.110     5.699     0.022     1.183     0.195  1.000  1.000  1.000  0.000  0.000    0.000   42.50
     11      45.00      0.302     1.379     0.097     5.686     0.021     1.273     0.148  1.000  1.000  1.000  0.000  0.000    0.000   47.50
     12      50.00      0.296     1.340     0.090     5.679     0.019     1.353     0.270  1.000  1.000  1.000  0.000  0.000    0.000   52.50
     13      55.00      0.314     1.270     0.076     5.664     0.012     1.428     0.220  1.000  1.000  1.000  0.000  0.000    0.000   57.50
     14      60.00      0.313     1.224     0.064     5.651     0.010     1.544     0.109  1.000  1.000  1.000  0.000  0.000    0.000   62.50
     15      65.00      0.331     1.210     0.061     5.646     0.008     1.653     0.217  1.000  1.000  1.000  0.000  0.000    0.000   67.50
     16      70.00      0.379     1.212     0.053     5.639     0.008     1.672     0.176  1.000  1.000  1.000  0.000  0.000    0.000   72.50
     17      75.00      0.374     1.202     0.045    12.231     0.007     1.669     0.106  1.000  1.000  1.000  0.000  0.000    0.000   77.50
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     18      80.00    0.363    1.194    0.041   12.231    0.006    1.690    0.070  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00    0.415    1.184    0.037   12.226    0.005    1.712    0.101  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00    0.411    1.165    0.032   12.221    0.004    1.768    0.065  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00    0.413    1.155    0.028   12.221    0.003    1.860    0.037  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00    0.320    1.150    0.025   12.223    0.005    1.929    0.039  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00    0.259    1.131    0.021   12.223    0.003    2.119    0.042  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00    0.262    1.112    0.017   12.236    0.000    2.303    0.044  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00    0.268    1.100    0.011   12.226   -0.001    2.440    0.044  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00    0.283    1.080    0.007   12.221   -0.002    2.592    0.047  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00    0.258    1.058    0.760                                              GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  5
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  6
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  7


 *********************
   NEXT INPUT MOTION
 *********************


 **********************************************************
 THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
 IN ORDER TO MEET THE COURANT STABILITY CRITERION
 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
 **********************************************************


 ***********************************************************
   OUTPUT FOR IVEC4140
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
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           TO TOP                                                        GAMMAX  DELTA  DETAG  DETAU                          MIDLAYER

     1       0.00    0.372    1.506    0.299    5.694   -0.072    0.082    0.009  1.000  1.000  1.000  0.000  0.000    0.000     2.00
     2       4.00    0.376    1.496    0.299    5.694   -0.072    0.239    0.055  0.966  0.966  0.966  0.000  0.000    0.000     6.00
     3       8.00    0.376    1.429    0.296    5.694   -0.072    0.388    0.109  0.951  0.951  0.951  0.000  0.000    0.000    10.00
     4      12.00    0.373    1.375    0.293    5.694   -0.074    0.522    0.175  0.941  0.941  0.941  0.000  0.000    0.000    13.50
     5      15.00    0.374    1.356    0.286    5.694   -0.075    0.670    0.146  0.949  0.949  0.949  0.000  0.000    0.000    17.50
     6      20.00    0.358    1.337    0.277    5.691   -0.070    0.849    0.358  0.923  0.923  0.923  0.000  0.000    0.000    22.50
     7      25.00    0.309    1.265    0.258    5.689   -0.067    1.014    1.035  0.875  0.874  0.874  0.000  0.000    0.000    27.50
     8      30.00    0.336    1.276    0.195    5.624   -0.048    1.158    0.231  1.000  1.000  1.000  0.000  0.000    0.000    32.50
     9      35.00    0.376    1.262    0.182    5.616   -0.044    1.307    0.258  1.000  1.000  1.000  0.000  0.000    0.000    37.50
    10      40.00    0.298    1.244    0.169    5.606   -0.043    1.442    0.240  1.000  1.000  1.000  0.000  0.000    0.000    42.50
    11      45.00    0.321    1.229    0.156    5.599   -0.041    1.559    0.185  1.000  1.000  1.000  0.000  0.000    0.000    47.50
    12      50.00    0.329    1.213    0.146    5.591   -0.039    1.662    0.386  1.000  1.000  1.000  0.000  0.000    0.000    52.50
    13      55.00    0.353    1.188    0.126    5.571   -0.027    1.714    0.335  1.000  1.000  1.000  0.000  0.000    0.000    57.50
    14      60.00    0.347    1.163    0.107    5.556   -0.016    1.782    0.136  1.000  1.000  1.000  0.000  0.000    0.000    62.50
    15      65.00    0.326    1.145    0.099    5.551   -0.014    1.881    0.313  1.000  1.000  1.000  0.000  0.000    0.000    67.50
    16      70.00    0.343    1.116    0.080    5.541   -0.007    1.992    0.231  1.000  1.000  1.000  0.000  0.000    0.000    72.50
    17      75.00    0.370    1.083    0.065    5.529   -0.001    2.166    0.146  1.000  1.000  1.000  0.000  0.000    0.000    77.50
    18      80.00    0.493    1.058    0.055    5.516    0.001    2.241    0.091  1.000  1.000  1.000  0.000  0.000    0.000    82.50
    19      85.00    0.372    1.036    0.050    5.511    0.002    2.370    0.154  1.000  1.000  1.000  0.000  0.000    0.000    87.50
    20      90.00    0.522    1.006    0.041    5.499    0.004    2.458    0.092  1.000  1.000  1.000  0.000  0.000    0.000    92.50
    21      95.00    0.471    0.981    0.035    5.496    0.003    2.620    0.055  1.000  1.000  1.000  0.000  0.000    0.000    97.50
    22     100.00    0.476    0.966    0.033    5.494    0.003    2.669    0.055  1.000  1.000  1.000  0.000  0.000    0.000   105.00
    23     110.00    0.328    0.932    0.027    5.489    0.002    2.858    0.061  1.000  1.000  1.000  0.000  0.000    0.000   115.00
    24     120.00    0.330    0.895    0.020    5.484    0.001    3.032    0.063  1.000  1.000  1.000  0.000  0.000    0.000   125.00
    25     130.00    0.322    0.869    0.013    5.476    0.001    3.114    0.061  1.000  1.000  1.000  0.000  0.000    0.000   135.00
    26     140.00    0.312    0.867    0.007    5.474    0.000    3.230    0.058  1.000  1.000  1.000  0.000  0.000    0.000   145.00
  BASE     150.00    0.298    0.867    0.524                                          GROUND SURFACE SETTLEMENT    0.000

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR IVEC4230
   WITH A PEAK ACCELERATION OF  0.40 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
           TO TOP                                                        GAMMAX  DELTA  DETAG  DETAU                          MIDLAYER

     1       0.00    0.348    1.935    0.254    5.676   -0.015    0.077    0.008  1.000  1.000  1.000  0.000  0.000    0.000     2.00
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    2     4.00   0.347   1.920   0.253   5.676  -0.015   0.224   0.051  0.960  0.960  0.960  0.000  0.000   0.000    6.00
    3     8.00   0.356   1.847   0.251   5.679  -0.015   0.367   0.098  0.941  0.941  0.941  0.000  0.000   0.000   10.00
    4    12.00   0.372   1.748   0.249   5.684  -0.014   0.495   0.165  0.924  0.924  0.924  0.000  0.000   0.000   13.50
    5    15.00   0.343   1.694   0.244   5.709  -0.014   0.608   0.139  0.931  0.931  0.931  0.000  0.000   0.000   17.50
    6    20.00   0.308   1.653   0.238   5.741  -0.015   0.754   0.329  0.893  0.893  0.893  0.000  0.000   0.000   22.50
    7    25.00   0.294   1.592   0.220   5.749  -0.019   0.888   0.810  0.822  0.821  0.821  0.000  0.000   0.000   27.50
    8    30.00   0.420   1.613   0.161   5.749  -0.003   1.004   0.209  1.000  1.000  1.000  0.000  0.000   0.000   32.50
    9    35.00   0.339   1.586   0.148   5.749  -0.010   1.093   0.212  1.000  1.000  1.000  0.000  0.000   0.000   37.50
   10    40.00   0.380   1.559   0.131   5.746  -0.014   1.156   0.182  1.000  1.000  1.000  0.000  0.000   0.000   42.50
   11    45.00   0.392   1.530   0.119   5.746  -0.012   1.201   0.145  1.000  1.000  1.000  0.000  0.000   0.000   47.50
   12    50.00   0.402   1.487   0.110   5.744  -0.011   1.280   0.266  1.000  1.000  1.000  0.000  0.000   0.000   52.50
   13    55.00   0.378   1.464   0.092   5.741  -0.013   1.411   0.232  1.000  1.000  1.000  0.000  0.000   0.000   57.50
   14    60.00   0.323   1.464   0.077   5.741  -0.008   1.587   0.121  1.000  1.000  1.000  0.000  0.000   0.000   62.50
   15    65.00   0.333   1.455   0.070   5.741  -0.008   1.710   0.239  1.000  1.000  1.000  0.000  0.000   0.000   67.50
   16    70.00   0.281   1.461   0.059   5.739  -0.001   1.827   0.196  1.000  1.000  1.000  0.000  0.000   0.000   72.50
   17    75.00   0.335   1.478   0.047   5.736   0.005   1.964   0.128  1.000  1.000  1.000  0.000  0.000   0.000   77.50
   18    80.00   0.390   1.477   0.040   5.726   0.003   2.122   0.085  1.000  1.000  1.000  0.000  0.000   0.000   82.50
   19    85.00   0.355   1.472   0.036   5.714   0.004   2.178   0.131  1.000  1.000  1.000  0.000  0.000   0.000   87.50
   20    90.00   0.470   1.466   0.029   5.711  -0.001   2.269   0.076  1.000  1.000  1.000  0.000  0.000   0.000   92.50
   21    95.00   0.445   1.468   0.026   5.711   0.000   2.354   0.046  1.000  1.000  1.000  0.000  0.000   0.000   97.50
   22   100.00   0.364   1.456   0.023   5.709  -0.001   2.440   0.046  1.000  1.000  1.000  0.000  0.000   0.000  105.00
   23   110.00   0.301   1.450   0.019   5.709  -0.002   2.570   0.051  1.000  1.000  1.000  0.000  0.000   0.000  115.00
   24   120.00   0.342   1.430   0.014   5.706  -0.003   2.756   0.051  1.000  1.000  1.000  0.000  0.000   0.000  125.00
   25   130.00   0.311   1.418   0.010   5.706  -0.002   2.897   0.054  1.000  1.000  1.000  0.000  0.000   0.000  135.00
   26   140.00   0.310   1.409   0.005   5.704  -0.001   3.012   0.052  1.000  1.000  1.000  0.000  0.000   0.000  145.00
  BASE  150.00   0.266   1.392   0.854                                            GROUND SURFACE SETTLEMENT   0.000

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  8
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  9
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 10
 HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 11

 FOR SECOND COMPONENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 12
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 13
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 14


*********************
  NEXT INPUT MOTION
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**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
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 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
 **********************************************************


 ***********************************************************
   OUTPUT FOR JOS000
   WITH A PEAK ACCELERATION OF  0.35 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                       GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.328    2.101    0.159   10.478   -0.094    0.072    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2       4.00    0.324    2.095    0.159   10.478   -0.095    0.215    0.051  0.952  0.952  0.952  0.000  0.000   0.000    6.00
      3       8.00    0.316    2.053    0.158   10.476   -0.093    0.350    0.104  0.928  0.928  0.928  0.000  0.000   0.000   10.00
      4      12.00    0.305    1.970    0.158   10.476   -0.090    0.458    0.170  0.910  0.910  0.910  0.000  0.000   0.000   13.50
      5      15.00    0.295    1.903    0.161   10.473   -0.081    0.577    0.129  0.922  0.922  0.922  0.000  0.000   0.000   17.50
      6      20.00    0.280    1.839    0.159   10.473   -0.076    0.710    0.297  0.883  0.883  0.883  0.000  0.000   0.000   22.50
      7      25.00    0.305    1.769    0.154   10.471   -0.043    0.788    0.566  0.833  0.833  0.833  0.000  0.000   0.000   27.50
      8      30.00    0.409    1.676    0.109   10.481   -0.019    0.839    0.140  1.000  1.000  1.000  0.000  0.000   0.000   32.50
      9      35.00    0.369    1.627    0.104   10.953   -0.020    0.941    0.159  1.000  1.000  1.000  0.000  0.000   0.000   37.50
     10      40.00    0.317    1.560    0.099   10.951   -0.018    1.020    0.163  1.000  1.000  1.000  0.000  0.000   0.000   42.50
     11      45.00    0.299    1.497    0.092   10.951   -0.018    1.133    0.132  1.000  1.000  1.000  0.000  0.000   0.000   47.50
     12      50.00    0.304    1.456    0.088   10.953   -0.019    1.249    0.234  1.000  1.000  1.000  0.000  0.000   0.000   52.50
     13      55.00    0.340    1.401    0.081   10.953   -0.021    1.318    0.210  1.000  1.000  1.000  0.000  0.000   0.000   57.50
     14      60.00    0.300    1.368    0.072   10.951   -0.022    1.398    0.100  1.000  1.000  1.000  0.000  0.000   0.000   62.50
     15      65.00    0.353    1.353    0.067   10.948   -0.022    1.452    0.199  1.000  1.000  1.000  0.000  0.000   0.000   67.50
     16      70.00    0.291    1.326    0.055   26.127   -0.017    1.542    0.162  1.000  1.000  1.000  0.000  0.000   0.000   72.50
     17      75.00    0.482    1.322    0.047   26.122   -0.012    1.721    0.104  1.000  1.000  1.000  0.000  0.000   0.000   77.50
     18      80.00    0.415    1.305    0.042   26.120   -0.010    1.801    0.060  1.000  1.000  1.000  0.000  0.000   0.000   82.50
     19      85.00    0.398    1.281    0.041   26.117   -0.011    1.889    0.094  1.000  1.000  1.000  0.000  0.000   0.000   87.50
     20      90.00    0.386    1.251    0.036   26.112   -0.012    2.019    0.064  1.000  1.000  1.000  0.000  0.000   0.000   92.50
     21      95.00    0.435    1.236    0.032   26.107   -0.011    2.036    0.035  1.000  1.000  1.000  0.000  0.000   0.000   97.50
     22     100.00    0.344    1.222    0.029   26.107   -0.009    2.107    0.039  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     23     110.00    0.247    1.194    0.024   26.102   -0.006    2.254    0.043  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     24     120.00    0.229    1.155    0.018   26.100   -0.005    2.442    0.042  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     25     130.00    0.242    1.126    0.012   26.092   -0.003    2.557    0.043  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     26     140.00    0.241    1.095    0.006   26.090   -0.001    2.667    0.043  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE    150.00    0.230    1.074    0.580                                               GROUND SURFACE SETTLEMENT   0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT
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 ***********************************************************
   OUTPUT FOR JOS090
   WITH A PEAK ACCELERATION OF  0.39 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME     DFINALR  TAUMAX   CYCLIC FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.313    1.766    0.428   27.062   -0.357    0.069    0.008  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2       4.00    0.323    1.757    0.428   27.062   -0.357    0.209    0.049  0.951  0.951  0.951  0.000  0.000   0.000    6.00
      3       8.00    0.322    1.699    0.425   27.062   -0.356    0.342    0.098  0.928  0.928  0.928  0.000  0.000   0.000   10.00
      4      12.00    0.323    1.617    0.422   27.060   -0.357    0.457    0.155  0.910  0.910  0.910  0.000  0.000   0.000   13.50
      5      15.00    0.321    1.541    0.414   28.550   -0.352    0.580    0.132  0.920  0.920  0.920  0.000  0.000   0.000   17.50
      6      20.00    0.316    1.457    0.405   28.550   -0.345    0.729    0.327  0.875  0.875  0.875  0.000  0.000   0.000   22.50
      7      25.00    0.299    1.363    0.385   28.545   -0.326    0.860    1.007  0.791  0.791  0.791  0.000  0.000   0.000   27.50
      8      30.00    0.404    1.477    0.269   33.982   -0.224    1.018    0.213  1.000  1.000  1.000  0.000  0.000   0.000   32.50
      9      35.00    0.395    1.453    0.248   33.970   -0.207    1.199    0.252  1.000  1.000  1.000  0.000  0.000   0.000   37.50
     10      40.00    0.317    1.418    0.219   33.955   -0.181    1.339    0.210  1.000  1.000  1.000  0.000  0.000   0.000   42.50
     11      45.00    0.308    1.392    0.187   33.942   -0.151    1.455    0.173  1.000  1.000  1.000  0.000  0.000   0.000   47.50
     12      50.00    0.302    1.357    0.166   33.935   -0.132    1.552    0.335  1.000  1.000  1.000  0.000  0.000   0.000   52.50
     13      55.00    0.303    1.303    0.121   26.945   -0.090    1.586    0.251  1.000  1.000  1.000  0.000  0.000   0.000   57.50
     14      60.00    0.307    1.252    0.101    9.936   -0.063    1.676    0.116  1.000  1.000  1.000  0.000  0.000   0.000   62.50
     15      65.00    0.295    1.216    0.092    9.931   -0.053    1.741    0.252  1.000  1.000  1.000  0.000  0.000   0.000   67.50
     16      70.00    0.313    1.162    0.074    9.911   -0.042    1.770    0.201  1.000  1.000  1.000  0.000  0.000   0.000   72.50
     17      75.00    0.329    1.168    0.059    9.894   -0.030    1.882    0.113  1.000  1.000  1.000  0.000  0.000   0.000   77.50
     18      80.00    0.371    1.178    0.051    9.884   -0.025    1.898    0.071  1.000  1.000  1.000  0.000  0.000   0.000   82.50
     19      85.00    0.325    1.179    0.045    9.881   -0.019    1.950    0.111  1.000  1.000  1.000  0.000  0.000   0.000   87.50
     20      90.00    0.352    1.186    0.036    9.871   -0.012    2.024    0.072  1.000  1.000  1.000  0.000  0.000   0.000   92.50
     21      95.00    0.443    1.188    0.032    9.866   -0.009    2.117    0.040  1.000  1.000  1.000  0.000  0.000   0.000   97.50
     22     100.00    0.317    1.188    0.029    9.864   -0.006    2.297    0.043  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     23     110.00    0.290    1.186    0.024    9.861   -0.005    2.514    0.048  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     24     120.00    0.287    1.187    0.018    9.859   -0.003    2.678    0.051  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     25     130.00    0.275    1.183    0.012    9.851   -0.001    2.808    0.048  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     26     140.00    0.293    1.177    0.007    9.866   -0.000    2.926    0.051  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE    150.00    0.288    1.164    0.551                                                GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 15
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 16
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 17
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 18
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  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 19
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 20
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 21


 *********************
   NEXT INPUT MOTION
 ********************


 **********************************************************
 THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
 IN ORDER TO MEET THE COURANT STABILITY CRITERION
 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
 **********************************************************


 ***********************************************************
   OUTPUT FOR NIS000
   WITH A PEAK ACCELERATION OF  0.39 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                      MIDLAYER

      1       0.00    0.320    1.720    0.198   11.011    0.018    0.070    0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2       4.00    0.312    1.714    0.198   11.011    0.018    0.206    0.047  0.957  0.957  0.957  0.000  0.000   0.000    6.00
      3       8.00    0.306    1.671    0.197   11.011    0.018    0.340    0.089  0.938  0.938  0.938  0.000  0.000   0.000   10.00
      4      12.00    0.348    1.598    0.194   11.011    0.017    0.451    0.163  0.922  0.921  0.921  0.000  0.000   0.000   13.50
      5      15.00    0.348    1.536    0.191   11.011    0.012    0.568    0.135  0.930  0.930  0.930  0.000  0.000   0.000   17.50
      6      20.00    0.285    1.491    0.186   11.011    0.010    0.702    0.307  0.892  0.892  0.892  0.000  0.000   0.000   22.50
      7      25.00    0.359    1.388    0.178   11.008    0.001    0.811    0.818  0.829  0.829  0.829  0.000  0.000   0.000   27.50
      8      30.00    0.407    1.294    0.147   10.993   -0.018    0.905    0.187  1.000  1.000  1.000  0.000  0.000   0.000   32.50
      9      35.00    0.381    1.284    0.133   10.991   -0.014    1.016    0.214  1.000  1.000  1.000  0.000  0.000   0.000   37.50
     10      40.00    0.316    1.240    0.122   10.988   -0.016    1.115    0.205  1.000  1.000  1.000  0.000  0.000   0.000   42.50
     11      45.00    0.329    1.190    0.108   10.983   -0.013    1.193    0.159  1.000  1.000  1.000  0.000  0.000   0.000   47.50
     12      50.00    0.369    1.148    0.103   10.981   -0.018    1.288    0.294  1.000  1.000  1.000  0.000  0.000   0.000   52.50
     13      55.00    0.339    1.095    0.088   12.083   -0.016    1.394    0.272  1.000  1.000  1.000  0.000  0.000   0.000   57.50
     14      60.00    0.323    1.075    0.074   12.076   -0.010    1.456    0.121  1.000  1.000  1.000  0.000  0.000   0.000   62.50
     15      65.00    0.326    1.064    0.067   12.071   -0.010    1.546    0.244  1.000  1.000  1.000  0.000  0.000   0.000   67.50
     16      70.00    0.300    1.028    0.053   12.063   -0.000    1.588    0.192  1.000  1.000  1.000  0.000  0.000   0.000   72.50
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     17      75.00     0.394     1.013     0.042    12.056    -0.001     1.645     0.112  1.000  1.000  1.000  0.000  0.000    0.000   77.50
     18      80.00     0.391     1.008     0.036    12.053    -0.001     1.722     0.068  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00     0.403     0.999     0.033    12.051     0.001     1.773     0.109  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00     0.382     0.969     0.027    12.046     0.002     1.920     0.069  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00     0.667     0.957     0.024    12.043     0.001     2.092     0.040  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00     0.354     0.948     0.021    12.043     0.002     2.204     0.041  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00     0.293     0.918     0.017    12.043     0.002     2.464     0.043  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00     0.298     0.873     0.014    12.673     0.003     2.687     0.049  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00     0.245     0.827     0.010    12.676     0.003     2.872     0.047  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00     0.257     0.788     0.005    12.673     0.001     3.001     0.049  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00     0.271     0.763     0.524                                               GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 ***********************************************************
   OUTPUT FOR NIS090
   WITH A PEAK ACCELERATION OF  0.36 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH      AMAX      VMAX      DMAXR      TIME     DFINALR   TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                                GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00     0.322     1.874     0.271    14.730     0.086     0.071     0.007  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2       4.00     0.317     1.864     0.271    14.730     0.086     0.206     0.046  0.961  0.961  0.961  0.000  0.000    0.000    6.00
      3       8.00     0.334     1.825     0.272    14.730     0.088     0.334     0.095  0.943  0.943  0.943  0.000  0.000    0.000   10.00
      4      12.00     0.335     1.765     0.267    14.733     0.086     0.447     0.162  0.925  0.925  0.925  0.000  0.000    0.000   13.50
      5      15.00     0.410     1.697     0.262    14.730     0.084     0.576     0.132  0.932  0.932  0.932  0.000  0.000    0.000   17.50
      6      20.00     0.324     1.631     0.252    14.733     0.079     0.722     0.295  0.895  0.894  0.894  0.000  0.000    0.000   22.50
      7      25.00     0.310     1.479     0.222    14.733     0.062     0.805     0.723  0.836  0.835  0.835  0.000  0.000    0.000   27.50
      8      30.00     0.381     1.364     0.129    14.728     0.014     0.936     0.173  1.000  1.000  1.000  0.000  0.000    0.000   32.50
      9      35.00     0.376     1.320     0.113    14.725     0.005     1.076     0.189  1.000  1.000  1.000  0.000  0.000    0.000   37.50
     10      40.00     0.361     1.274     0.100    14.720    -0.000     1.193     0.184  1.000  1.000  1.000  0.000  0.000    0.000   42.50
     11      45.00     0.351     1.248     0.087    14.715    -0.004     1.279     0.133  1.000  1.000  1.000  0.000  0.000    0.000   47.50
     12      50.00     0.348     1.223     0.082    14.718    -0.002     1.345     0.237  1.000  1.000  1.000  0.000  0.000    0.000   52.50
     13      55.00     0.321     1.227     0.080    14.713     0.007     1.376     0.209  1.000  1.000  1.000  0.000  0.000    0.000   57.50
     14      60.00     0.333     1.235     0.059    14.718    -0.004     1.478     0.100  1.000  1.000  1.000  0.000  0.000    0.000   62.50
     15      65.00     0.350     1.224     0.056    14.718    -0.002     1.484     0.177  1.000  1.000  1.000  0.000  0.000    0.000   67.50
     16      70.00     0.359     1.212     0.045     8.356    -0.012     1.556     0.146  1.000  1.000  1.000  0.000  0.000    0.000   72.50
     17      75.00     0.343     1.208     0.040     8.351    -0.013     1.637     0.093  1.000  1.000  1.000  0.000  0.000    0.000   77.50
     18      80.00     0.303     1.199     0.037     8.349    -0.013     1.752     0.064  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00     0.378     1.187     0.035    11.946    -0.013     1.788     0.105  1.000  1.000  1.000  0.000  0.000    0.000   87.50
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     20      90.00    0.379    1.147    0.033   11.943   -0.014    1.873    0.067  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00    0.509    1.134    0.029   11.941   -0.014    1.996    0.037  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00    0.318    1.120    0.028   11.938   -0.013    2.073    0.040  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00    0.274    1.101    0.024   11.936   -0.013    2.137    0.043  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00    0.257    1.073    0.018   11.933   -0.010    2.217    0.046  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00    0.270    1.042    0.011   11.933   -0.006    2.337    0.045  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00    0.276    1.010    0.005   11.931   -0.003    2.486    0.048  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00    0.241    0.994    0.613                                              GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 22
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 23
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 24
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 25

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 26
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 27
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 28


 *********************
   NEXT INPUT MOTION
 *********************


 **********************************************************
 THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
 IN ORDER TO MEET THE COURANT STABILITY CRITERION
 ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
 **********************************************************


 ***********************************************************
   OUTPUT FOR YAR060
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.    DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
             TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER
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     1       0.00     0.346     1.488     0.145    16.060     0.125     0.076     0.008  1.000  1.000  1.000  0.000  0.000    0.000     2.00
     2       4.00     0.347     1.484     0.145    16.060     0.125     0.223     0.050  0.960  0.960  0.960  0.000  0.000    0.000     6.00
     3       8.00     0.313     1.465     0.144    16.060     0.124     0.356     0.094  0.941  0.941  0.941  0.000  0.000    0.000    10.00
     4      12.00     0.319     1.417     0.140    16.058     0.123     0.452     0.138  0.927  0.926  0.926  0.000  0.000    0.000    13.50
     5      15.00     0.307     1.375     0.134    16.058     0.117     0.562     0.122  0.934  0.934  0.934  0.000  0.000    0.000    17.50
     6      20.00     0.287     1.321     0.126    16.055     0.111     0.712     0.288  0.898  0.898  0.898  0.000  0.000    0.000    22.50
     7      25.00     0.299     1.343     0.117    16.040     0.092     0.847     0.637  0.853  0.852  0.852  0.000  0.000    0.000    27.50
     8      30.00     0.375     1.363     0.102    16.478     0.040     0.933     0.159  1.000  1.000  1.000  0.000  0.000    0.000    32.50
     9      35.00     0.374     1.375     0.098    16.475     0.031     1.079     0.157  1.000  1.000  1.000  0.000  0.000    0.000    37.50
    10      40.00     0.316     1.348     0.095    16.473     0.020     1.216     0.223  1.000  1.000  1.000  0.000  0.000    0.000    42.50
    11      45.00     0.345     1.306     0.088    16.463     0.018     1.320     0.165  1.000  1.000  1.000  0.000  0.000    0.000    47.50
    12      50.00     0.337     1.272     0.080    16.455     0.020     1.403     0.313  1.000  1.000  1.000  0.000  0.000    0.000    52.50
    13      55.00     0.322     1.240     0.067    16.435     0.025     1.438     0.259  1.000  1.000  1.000  0.000  0.000    0.000    57.50
    14      60.00     0.347     1.213     0.058    16.423     0.025     1.507     0.101  1.000  1.000  1.000  0.000  0.000    0.000    62.50
    15      65.00     0.330     1.191     0.054    16.420     0.021     1.662     0.197  1.000  1.000  1.000  0.000  0.000    0.000    67.50
    16      70.00     0.424     1.167     0.045    16.410     0.017     1.774     0.167  1.000  1.000  1.000  0.000  0.000    0.000    72.50
    17      75.00     0.351     1.137     0.038    16.403     0.013     1.811     0.111  1.000  1.000  1.000  0.000  0.000    0.000    77.50
    18      80.00     0.397     1.126     0.034    16.405     0.010     1.880     0.074  1.000  1.000  1.000  0.000  0.000    0.000    82.50
    19      85.00     0.378     1.126     0.032    16.408     0.007     1.933     0.114  1.000  1.000  1.000  0.000  0.000    0.000    87.50
    20      90.00     0.351     1.125     0.026    16.403     0.005     2.026     0.075  1.000  1.000  1.000  0.000  0.000    0.000    92.50
    21      95.00     0.399     1.123     0.022    16.410     0.004     2.123     0.039  1.000  1.000  1.000  0.000  0.000    0.000    97.50
    22     100.00     0.339     1.121     0.020    16.400     0.004     2.226     0.044  1.000  1.000  1.000  0.000  0.000    0.000   105.00
    23     110.00     0.301     1.118     0.016    16.400     0.003     2.340     0.046  1.000  1.000  1.000  0.000  0.000    0.000   115.00
    24     120.00     0.284     1.115     0.013    16.400     0.001     2.458     0.053  1.000  1.000  1.000  0.000  0.000    0.000   125.00
    25     130.00     0.281     1.108     0.009    16.408     0.001     2.591     0.047  1.000  1.000  1.000  0.000  0.000    0.000   135.00
    26     140.00     0.298     1.102     0.005    16.985     0.002     2.725     0.050  1.000  1.000  1.000  0.000  0.000    0.000   145.00
   BASE    150.00     0.314     1.095     0.540                                                      GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR YAR330
   WITH A PEAK ACCELERATION OF  0.43 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH      AMAX      VMAX      DMAXR      TIME     DFINALR   TAUMAX     CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                                GAMMAX  DELTA  DETAG  DETAU                        MIDLAYER

     1       0.00     0.367     1.473     0.363    17.890     0.276     0.081     0.009  1.000  1.000  1.000  0.000  0.000    0.000     2.00
     2       4.00     0.373     1.472     0.363    17.893     0.276     0.236     0.051  0.962  0.962  0.962  0.000  0.000    0.000     6.00
     3       8.00     0.360     1.463     0.363    17.890     0.278     0.385     0.116  0.942  0.942  0.942  0.000  0.000    0.000    10.00
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    4      12.00     0.318     1.441     0.357    17.893     0.275     0.507     0.187  0.927  0.926  0.926  0.000  0.000    0.000   13.50
    5      15.00     0.308     1.416     0.348    17.890     0.272     0.630     0.154  0.934  0.934  0.934  0.000  0.000    0.000   17.50
    6      20.00     0.307     1.381     0.340    17.890     0.268     0.768     0.368  0.895  0.895  0.895  0.000  0.000    0.000   22.50
    7      25.00     0.305     1.343     0.308    17.885     0.245     0.895     1.063  0.828  0.828  0.828  0.000  0.000    0.000   27.50
    8      30.00     0.322     1.283     0.166    17.858     0.121     0.967     0.206  1.000  1.000  1.000  0.000  0.000    0.000   32.50
    9      35.00     0.314     1.235     0.149    17.855     0.109     1.054     0.221  1.000  1.000  1.000  0.000  0.000    0.000   37.50
   10      40.00     0.324     1.180     0.138    17.850     0.101     1.181     0.193  1.000  1.000  1.000  0.000  0.000    0.000   42.50
   11      45.00     0.319     1.130     0.127    17.848     0.094     1.320     0.135  1.000  1.000  1.000  0.000  0.000    0.000   47.50
   12      50.00     0.293     1.088     0.117    17.848     0.087     1.459     0.266  1.000  1.000  1.000  0.000  0.000    0.000   52.50
   13      55.00     0.427     1.025     0.098    17.843     0.070     1.534     0.201  1.000  1.000  1.000  0.000  0.000    0.000   57.50
   14      60.00     0.424     1.010     0.083    17.835     0.057     1.575     0.096  1.000  1.000  1.000  0.000  0.000    0.000   62.50
   15      65.00     0.409     0.998     0.079    17.833     0.055     1.641     0.186  1.000  1.000  1.000  0.000  0.000    0.000   67.50
   16      70.00     0.367     0.990     0.069    17.830     0.048     1.757     0.152  1.000  1.000  1.000  0.000  0.000    0.000   72.50
   17      75.00     0.384     0.989     0.058    17.830     0.039     1.774     0.105  1.000  1.000  1.000  0.000  0.000    0.000   77.50
   18      80.00     0.482     0.985     0.053    17.828     0.037     1.887     0.073  1.000  1.000  1.000  0.000  0.000    0.000   82.50
   19      85.00     0.396     0.975     0.049    17.833     0.035     2.014     0.117  1.000  1.000  1.000  0.000  0.000    0.000   87.50
   20      90.00     0.388     0.963     0.042    17.825     0.032     2.111     0.072  1.000  1.000  1.000  0.000  0.000    0.000   92.50
   21      95.00     0.409     0.950     0.037    17.825     0.027     2.241     0.043  1.000  1.000  1.000  0.000  0.000    0.000   97.50
   22     100.00     0.389     0.941     0.034    17.828     0.026     2.478     0.049  1.000  1.000  1.000  0.000  0.000    0.000  105.00
   23     110.00     0.365     0.917     0.029    17.815     0.023     2.770     0.058  1.000  1.000  1.000  0.000  0.000    0.000  115.00
   24     120.00     0.339     0.889     0.022     9.949     0.017     2.991     0.064  1.000  1.000  1.000  0.000  0.000    0.000  125.00
   25     130.00     0.311     0.857     0.014    17.813     0.011     3.126     0.058  1.000  1.000  1.000  0.000  0.000    0.000  135.00
   26     140.00     0.311     0.852     0.008    17.815     0.006     3.204     0.059  1.000  1.000  1.000  0.000  0.000    0.000  145.00
  BASE    150.00     0.297     0.850     0.564                                                 GROUND SURFACE SETTLEMENT    0.000

 DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
 DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 29
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 30
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 31
 HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 32

 FOR SECOND COMPONENT

 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 33
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 34
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 35


*********************
  NEXT INPUT MOTION
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**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
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 ***********************************************************
   OUTPUT FOR UC2000
   WITH A PEAK ACCELERATION OF  0.42 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1      0.00    0.320    1.460    0.233    9.426    0.028    0.070    0.007  1.000  1.000  1.000  0.000  0.000   0.000    2.00
      2      4.00    0.320    1.453    0.232    9.426    0.028    0.209    0.045  0.958  0.958  0.958  0.000  0.000   0.000    6.00
      3      8.00    0.339    1.430    0.231    9.426    0.027    0.342    0.093  0.938  0.938  0.938  0.000  0.000   0.000   10.00
      4     12.00    0.350    1.398    0.228    9.426    0.028    0.452    0.143  0.922  0.921  0.921  0.000  0.000   0.000   13.50
      5     15.00    0.298    1.369    0.224    9.424    0.026    0.574    0.128  0.929  0.928  0.928  0.000  0.000   0.000   17.50
      6     20.00    0.328    1.332    0.214    9.424    0.028    0.720    0.328  0.889  0.886  0.886  0.000  0.000   0.000   22.50
      7     25.00    0.303    1.281    0.192    9.421    0.038    0.827    0.833  0.823  0.819  0.819  0.000  0.000   0.000   27.50
      8     30.00    0.347    1.280    0.140    9.401    0.068    0.955    0.167  1.000  1.000  1.000  0.000  0.000   0.000   32.50
      9     35.00    0.364    1.289    0.126   10.284    0.062    1.161    0.181  1.000  1.000  1.000  0.000  0.000   0.000   37.50
     10     40.00    0.316    1.299    0.115   10.279    0.053    1.318    0.166  1.000  1.000  1.000  0.000  0.000   0.000   42.50
     11     45.00    0.374    1.295    0.105   10.274    0.049    1.453    0.121  1.000  1.000  1.000  0.000  0.000   0.000   47.50
     12     50.00    0.297    1.281    0.098   10.271    0.045    1.574    0.211  1.000  1.000  1.000  0.000  0.000   0.000   52.50
     13     55.00    0.319    1.243    0.090   10.269    0.041    1.673    0.180  1.000  1.000  1.000  0.000  0.000   0.000   57.50
     14     60.00    0.366    1.204    0.080   10.266    0.031    1.773    0.101  1.000  1.000  1.000  0.000  0.000   0.000   62.50
     15     65.00    0.317    1.176    0.074   10.264    0.029    1.896    0.186  1.000  1.000  1.000  0.000  0.000   0.000   67.50
     16     70.00    0.356    1.133    0.067   10.261    0.024    1.986    0.190  1.000  1.000  1.000  0.000  0.000   0.000   72.50
     17     75.00    0.402    1.096    0.058   10.251    0.019    2.143    0.113  1.000  1.000  1.000  0.000  0.000   0.000   77.50
     18     80.00    0.392    1.068    0.053   10.246    0.016    2.151    0.080  1.000  1.000  1.000  0.000  0.000   0.000   82.50
     19     85.00    0.480    1.046    0.050   10.244    0.015    2.402    0.129  1.000  1.000  1.000  0.000  0.000   0.000   87.50
     20     90.00    0.470    1.022    0.041   10.239    0.009    2.469    0.076  1.000  1.000  1.000  0.000  0.000   0.000   92.50
     21     95.00    0.490    1.008    0.037   10.236    0.007    2.658    0.046  1.000  1.000  1.000  0.000  0.000   0.000   97.50
     22    100.00    0.438    0.994    0.034   10.236    0.005    2.750    0.051  1.000  1.000  1.000  0.000  0.000   0.000  105.00
     23    110.00    0.316    0.978    0.026   10.234    0.002    3.023    0.056  1.000  1.000  1.000  0.000  0.000   0.000  115.00
     24    120.00    0.301    0.986    0.021   10.231    0.002    3.239    0.060  1.000  1.000  1.000  0.000  0.000   0.000  125.00
     25    130.00    0.265    0.996    0.014   10.224    0.002    3.387    0.053  1.000  1.000  1.000  0.000  0.000   0.000  135.00
     26    140.00    0.307    1.000    0.009   10.239    0.002    3.534    0.066  1.000  1.000  1.000  0.000  0.000   0.000  145.00
    BASE   150.00    0.299    1.002    0.745                                                GROUND SURFACE SETTLEMENT   0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


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   OUTPUT FOR UC2090
   WITH A PEAK ACCELERATION OF  0.34 G
   AND SLOPE = 0.00
 ***********************************************************

 *****************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 *****************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.316    1.662    0.274    11.636   -0.037    0.069    0.007  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2       4.00    0.327    1.657    0.273    11.636   -0.037    0.206    0.049  0.958  0.958  0.958  0.000  0.000    0.000    6.00
      3       8.00    0.319    1.644    0.272    11.636   -0.038    0.338    0.107  0.938  0.938  0.938  0.000  0.000    0.000   10.00
      4      12.00    0.343    1.592    0.266    11.633   -0.037    0.446    0.166  0.922  0.920  0.920  0.000  0.000    0.000   13.50
      5      15.00    0.361    1.557    0.258    11.633   -0.036    0.558    0.140  0.929  0.928  0.928  0.000  0.000    0.000   17.50
      6      20.00    0.337    1.554    0.248    11.631   -0.035    0.688    0.373  0.890  0.886  0.886  0.000  0.000    0.000   22.50
      7      25.00    0.383    1.494    0.226    11.623   -0.032    0.796    1.013  0.822  0.817  0.817  0.000  0.000    0.000   27.50
      8      30.00    0.382    1.369    0.139    11.581   -0.012    0.908    0.189  1.000  1.000  1.000  0.000  0.000    0.000   32.50
      9      35.00    0.357    1.323    0.132    11.573   -0.014    1.065    0.196  1.000  1.000  1.000  0.000  0.000    0.000   37.50
     10      40.00    0.329    1.263    0.121    11.566   -0.010    1.199    0.172  1.000  1.000  1.000  0.000  0.000    0.000   42.50
     11      45.00    0.324    1.211    0.113    11.556   -0.006    1.299    0.124  1.000  1.000  1.000  0.000  0.000    0.000   47.50
     12      50.00    0.285    1.177    0.108    11.538   -0.007    1.377    0.208  1.000  1.000  1.000  0.000  0.000    0.000   52.50
     13      55.00    0.298    1.130    0.096    11.511   -0.008    1.469    0.186  1.000  1.000  1.000  0.000  0.000    0.000   57.50
     14      60.00    0.317    1.087    0.084    11.498   -0.006    1.484    0.094  1.000  1.000  1.000  0.000  0.000    0.000   62.50
     15      65.00    0.317    1.057    0.080    11.498   -0.007    1.538    0.168  1.000  1.000  1.000  0.000  0.000    0.000   67.50
     16      70.00    0.390    1.018    0.069    11.496   -0.008    1.630    0.145  1.000  1.000  1.000  0.000  0.000    0.000   72.50
     17      75.00    0.291    0.981    0.058    11.493   -0.010    1.698    0.091  1.000  1.000  1.000  0.000  0.000    0.000   77.50
     18      80.00    0.366    0.977    0.051    11.498   -0.010    1.780    0.064  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00    0.309    0.968    0.047    11.493   -0.010    1.864    0.097  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00    0.369    0.960    0.041    11.498   -0.010    1.963    0.066  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00    0.466    0.955    0.035    11.496   -0.008    2.062    0.039  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00    0.344    0.952    0.033    11.493   -0.008    2.062    0.039  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00    0.271    0.941    0.028    11.493   -0.007    2.217    0.043  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00    0.258    0.930    0.021    11.488   -0.006    2.352    0.046  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00    0.259    0.907    0.013    11.481   -0.002    2.456    0.041  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00    0.275    0.887    0.007    11.498   -0.001    2.544    0.045  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00    0.241    0.863    0.597                                                GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 36
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 37
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 38
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 39

  FOR SECOND COMPONENT
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 HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 40
 HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 41
 HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 42


*********************
  NEXT INPUT MOTION
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**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
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***********************************************************
  OUTPUT FOR LOB000
  WITH A PEAK ACCELERATION OF  0.36 G
  AND SLOPE = 0.00
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******************************************************
  MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
******************************************************

LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME     DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                              MIDLAYER

      1       0.00    0.333    1.711    0.176   11.153     0.061    0.073    0.008  1.000  1.000  1.000  0.000  0.000   0.000     2.00
      2       4.00    0.343    1.704    0.175   11.153     0.061    0.218    0.050  0.958  0.958  0.958  0.000  0.000   0.000     6.00
      3       8.00    0.339    1.651    0.176   11.153     0.063    0.355    0.097  0.938  0.938  0.938  0.000  0.000   0.000    10.00
      4      12.00    0.331    1.569    0.174   11.153     0.064    0.467    0.154  0.922  0.919  0.919  0.000  0.000   0.000    13.50
      5      15.00    0.323    1.513    0.173   11.153     0.066    0.583    0.138  0.928  0.926  0.926  0.000  0.000   0.000    17.50
      6      20.00    0.296    1.446    0.170   11.861     0.065    0.720    0.326  0.891  0.884  0.884  0.000  0.000   0.000    22.50
      7      25.00    0.300    1.321    0.155   11.848     0.059    0.836    0.823  0.822  0.810  0.810  0.000  0.000   0.000    27.50
      8      30.00    0.353    1.339    0.140   11.831     0.086    0.917    0.195  1.000  1.000  1.000  0.000  0.000   0.000    32.50
      9      35.00    0.309    1.307    0.136   11.826     0.087    1.006    0.197  1.000  1.000  1.000  0.000  0.000   0.000    37.50
     10      40.00    0.322    1.271    0.129   11.821     0.085    1.104    0.167  1.000  1.000  1.000  0.000  0.000   0.000    42.50
     11      45.00    0.309    1.235    0.117   11.816     0.080    1.197    0.128  1.000  1.000  1.000  0.000  0.000   0.000    47.50
     12      50.00    0.314    1.206    0.107   11.813     0.070    1.275    0.227  1.000  1.000  1.000  0.000  0.000   0.000    52.50
     13      55.00    0.267    1.176    0.088   11.808     0.054    1.311    0.203  1.000  1.000  1.000  0.000  0.000   0.000    57.50
     14      60.00    0.308    1.147    0.071   11.806     0.041    1.376    0.101  1.000  1.000  1.000  0.000  0.000   0.000    62.50
     15      65.00    0.264    1.141    0.066   11.803     0.037    1.443    0.204  1.000  1.000  1.000  0.000  0.000   0.000    67.50
     16      70.00    0.313    1.094    0.050   11.798     0.025    1.505    0.158  1.000  1.000  1.000  0.000  0.000   0.000    72.50
     17      75.00    0.306    1.071    0.042   10.656     0.012    1.573    0.088  1.000  1.000  1.000  0.000  0.000   0.000    77.50
     18      80.00    0.392    1.051    0.038   10.653     0.010    1.641    0.063  1.000  1.000  1.000  0.000  0.000   0.000    82.50
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     19      85.00    0.345    1.029    0.036   10.648    0.007    1.690    0.089  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00    0.384    1.005    0.030   10.641    0.007    1.814    0.061  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00    0.393    0.993    0.027   10.638    0.007    1.909    0.037  1.000  1.000  1.000  0.000  0.000    0.000   97.50
     22     100.00    0.339    0.978    0.025   10.641    0.007    2.052    0.039  1.000  1.000  1.000  0.000  0.000    0.000  105.00
     23     110.00    0.283    0.934    0.021   10.636    0.004    2.275    0.044  1.000  1.000  1.000  0.000  0.000    0.000  115.00
     24     120.00    0.279    0.905    0.016   10.628    0.005    2.443    0.047  1.000  1.000  1.000  0.000  0.000    0.000  125.00
     25     130.00    0.270    0.885    0.012   10.648    0.003    2.661    0.047  1.000  1.000  1.000  0.000  0.000    0.000  135.00
     26     140.00    0.279    0.873    0.006   10.628    0.003    2.883    0.050  1.000  1.000  1.000  0.000  0.000    0.000  145.00
    BASE    150.00    0.247    0.852    0.576                                                GROUND SURFACE SETTLEMENT    0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT



 **********************************************************
   OUTPUT FOR LOB090
   WITH A PEAK ACCELERATION OF  0.38 G
   AND SLOPE = 0.00
 **********************************************************

 *****************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 *****************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME     DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.344    1.482    0.246    8.574   -0.084    0.076    0.008  1.000  1.000  1.000  0.000  0.000    0.000    2.00
      2       4.00    0.338    1.478    0.246    8.574   -0.084    0.224    0.049  0.956  0.956  0.956  0.000  0.000    0.000    6.00
      3       8.00    0.322    1.459    0.244    8.574   -0.083    0.365    0.098  0.933  0.933  0.933  0.000  0.000    0.000   10.00
      4      12.00    0.310    1.443    0.241    8.571   -0.083    0.478    0.164  0.915  0.915  0.915  0.000  0.000    0.000   13.50
      5      15.00    0.332    1.428    0.230    8.571   -0.076    0.597    0.145  0.924  0.923  0.923  0.000  0.000    0.000   17.50
      6      20.00    0.312    1.403    0.218    8.569   -0.064    0.725    0.342  0.882  0.881  0.881  0.000  0.000    0.000   22.50
      7      25.00    0.293    1.354    0.186    8.564   -0.045    0.817    0.869  0.817  0.815  0.815  0.000  0.000    0.000   27.50
      8      30.00    0.401    1.333    0.133    8.516   -0.054    0.886    0.185  1.000  1.000  1.000  0.000  0.000    0.000   32.50
      9      35.00    0.334    1.310    0.122    9.421   -0.049    0.971    0.185  1.000  1.000  1.000  0.000  0.000    0.000   37.50
     10      40.00    0.327    1.287    0.114    9.416   -0.045    1.061    0.160  1.000  1.000  1.000  0.000  0.000    0.000   42.50
     11      45.00    0.370    1.271    0.105    9.411   -0.042    1.180    0.117  1.000  1.000  1.000  0.000  0.000    0.000   47.50
     12      50.00    0.347    1.258    0.098    9.409   -0.038    1.276    0.195  1.000  1.000  1.000  0.000  0.000    0.000   52.50
     13      55.00    0.457    1.247    0.086    9.406   -0.030    1.369    0.192  1.000  1.000  1.000  0.000  0.000    0.000   57.50
     14      60.00    0.482    1.223    0.076    9.404   -0.028    1.475    0.094  1.000  1.000  1.000  0.000  0.000    0.000   62.50
     15      65.00    0.372    1.208    0.069    9.401   -0.025    1.573    0.183  1.000  1.000  1.000  0.000  0.000    0.000   67.50
     16      70.00    0.325    1.178    0.060    9.399   -0.021    1.685    0.154  1.000  1.000  1.000  0.000  0.000    0.000   72.50
     17      75.00    0.341    1.148    0.051    9.394   -0.017    1.814    0.098  1.000  1.000  1.000  0.000  0.000    0.000   77.50
     18      80.00    0.391    1.122    0.046    9.394   -0.016    1.942    0.068  1.000  1.000  1.000  0.000  0.000    0.000   82.50
     19      85.00    0.370    1.099    0.042    9.391   -0.015    2.065    0.106  1.000  1.000  1.000  0.000  0.000    0.000   87.50
     20      90.00    0.339    1.071    0.036    9.389   -0.011    2.200    0.067  1.000  1.000  1.000  0.000  0.000    0.000   92.50
     21      95.00    0.388    1.057    0.033    9.386   -0.010    2.319    0.041  1.000  1.000  1.000  0.000  0.000    0.000   97.50
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   22     100.00    0.342    1.043    0.031    9.386   -0.010    2.519    0.043  1.000  1.000  1.000  0.000  0.000   0.000  105.00
   23     110.00    0.291    1.011    0.027    9.384   -0.008    2.706    0.046  1.000  1.000  1.000  0.000  0.000   0.000  115.00
   24     120.00    0.299    0.981    0.020    9.381   -0.006    2.835    0.047  1.000  1.000  1.000  0.000  0.000   0.000  125.00
   25     130.00    0.325    0.949    0.013    9.379   -0.004    2.918    0.050  1.000  1.000  1.000  0.000  0.000   0.000  135.00
   26     140.00    0.297    0.931    0.007    9.386   -0.001    2.964    0.050  1.000  1.000  1.000  0.000  0.000   0.000  145.00
  BASE    150.00    0.270    0.923    0.741                                               GROUND SURFACE SETTLEMENT   0.000

DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 43
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 44
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 45
HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 46

FOR SECOND COMPONENT

HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER 47
HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 48
HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER 49


**************************************
NORMAL TERMINATION FOR THIS INPUT FILE
**************************************
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**************************************************
**************************************************

 TESS2 - Version 3.00C
 Copyright 2020 Robert Pyke
 Built by rmp on 08/22/2020
 Using Simply Fortran v. 2.4

**************************************************
**************************************************

INPUT/OUTPUT FILE NAME: bh2bp


****************************************
130 Center Street  EB-2
****************************************
Under basement  150-foot profile WITH PR
****************************************


REDISTRIBUTION AND DISSIPATION OF PORE PRESSURES
IS NOT INCLUDED!


CALCULATION OF SETTLEMENTS IS TURNED ON


UNITS ARE KIPS, FEET AND SECONDS


 FOR APPLIED WEIGHT WITHOUT PILES OR COLUMNS

 APPLIED WEIGHT PER UNIT AREA =    1.80

 LAYER NUMBER  REDUCTION FACTOR
      1             1.00
      2             1.00
      3             1.00
      4             1.00
      5             1.00
      6             1.00
      7             1.00
      8             1.00
      9             1.00
     10             1.00
     11             1.00
     12             1.00
     13             1.00
     14             1.00
```

```
     15              1.00
     16              1.00
     17              1.00
     18              1.00
     19              1.00
     20              1.00
     21              1.00
     22              1.00

**********
INPUT DATA
**********

MATERIAL PROPERTY PARAMETERS

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  1         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  2         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  3         0.02      1.00      0.00      0.00      0.00

 MTYPE        VT     ALPHA      GMRP      TSTR      FSTR
  4         0.02      1.00      0.00      0.00      0.00


PARAMETERS FOR SIMPLE DEGRADATION

   MTYPE    SS        RS         E       SG        RG         ST        RT
    2      0.12      0.65      1.50      0.12      0.65      0.12      0.65


PARAMETERS FOR PORE PRESSURE GENERATION CURVES

 LAYER NO.   MTYPE  TAUAV/SIGV   NL         E            F            G


PARAMETERS FOR SETTLEMENT CALCULATIONS

 LAYER NO.  ARD    FACTOR


PARAMETERS FOR HARDENING OF SHEAR MODULUS

 MAT.TYPE  KHARD  FHARD  FHARDS
      3      1    1.00    0.50
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      4       1    1.00    0.50


**********************************************************
THE TIMESTEP HAS BEEN REDUCED BY A FACTOR OF  4
IN ORDER TO MEET THE COURANT STABILITY CRITERION
ALTERNATELY YOU MAY INCREASE THE LAYER THICKNESS(ES)
**********************************************************


**********
LAYER DATA
**********

DEPTH TO WATER TABLE =   5.00
TRAVEL TIMES ARE RELATIVE TO A TIMESTEP OF 0.0025 SECONDS

 LAYER NO.   MTYPE   THICK   UNIT WT   OCR    KO    SIGV        VS         GMAX        TAUMAX    GAMREF      TTR

     1       2        5.00     0.110                2.08       480.00       787.08     1.968     0.250     0.240
     2       2        5.00     0.110                2.47       450.00       691.77     1.384     0.200     0.225
     3       2        5.00     0.110                2.71       420.00       602.61     1.205     0.200     0.210
     4       1        5.00     0.120                2.97       530.00      1046.83     2.094     0.200     0.265
     5       1        5.00     0.120                3.26       550.00      1127.33     2.255     0.200     0.275
     6       1        5.00     0.120                3.55       590.00      1297.27     2.595     0.200     0.295
     7       1        5.00     0.120                3.83       705.00      1852.27     2.778     0.150     0.352
     8       1        5.00     0.120                4.12       635.00      1502.70     2.254     0.150     0.317
     9       1        5.00     0.120                4.41       670.00      1672.92     2.509     0.150     0.335
    10       1        5.00     0.120                4.70       780.00      2267.33     4.535     0.200     0.390
    11       1        5.00     0.120                4.99       656.00      1603.74     3.207     0.200     0.328
    12       1        5.00     0.120                5.27       706.00      1857.53     3.715     0.200     0.353
    13       1        5.00     0.120                5.56       833.00      2585.92     5.172     0.200     0.417
    14       1        5.00     0.120                5.85       977.00      3557.25     7.115     0.200     0.488
    15       1        5.00     0.120                6.14       855.00      2724.32     5.449     0.200     0.427
    16       1        5.00     0.120                6.43      1016.00      3846.92     7.694     0.200     0.508
    17       1        5.00     0.120                6.71      1287.00      6172.80    12.346     0.200     0.643
    18       1       10.00     0.120                7.15      1300.00      6298.14    12.596     0.200     0.325
    19       1       10.00     0.120                7.72      1300.00      6298.14    12.596     0.200     0.325
    20       1       10.00     0.120                8.30      1300.00      6298.14    12.596     0.200     0.325
    21       1       10.00     0.120                8.87      1370.00      6994.66    13.989     0.200     0.343
    22       1       10.00     0.120                9.45      1370.00      6994.66    13.989     0.200     0.343

SHEAR WAVE VELOCITY IN BASE =  2500.
UNIT WEIGHT OF BASE =   0.130


***********************************************************
  OUTPUT FOR IV02180
  WITH A PEAK ACCELERATION OF  0.36 G
```

```
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************


LAYER NO.   DEPTH     AMAX     VMAX     DMAXR    TIME    DFINALR  TAUMAX   CYCLIC  FINAL  FINAL  FINAL  UMAX   UFINAL SETTLE DEPTH TO
            TO TOP                                                         GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.111    1.103    0.366   35.864   -0.264    0.530    0.106  0.937  0.937  0.937  0.000  0.000   0.000     2.50
      2       5.00    0.104    1.066    0.367   35.861   -0.268    1.006    0.591  0.858  0.858  0.858  0.000  0.000   0.000     7.50
      3      10.00    0.336    1.006    0.335   35.854   -0.244    1.026    2.717  0.724  0.723  0.723  0.000  0.000   0.000    12.50
      4      15.00    0.490    1.194    0.140    4.504    0.035    1.127    0.155  1.000  1.000  1.000  0.000  0.000   0.000    17.50
      5      20.00    0.443    1.169    0.128    4.501    0.037    1.302    0.165  1.000  1.000  1.000  0.000  0.000   0.000    22.50
      6      25.00    0.418    1.102    0.118    4.496    0.033    1.453    0.155  1.000  1.000  1.000  0.000  0.000   0.000    27.50
      7      30.00    0.426    1.080    0.109    4.491    0.027    1.567    0.124  1.000  1.000  1.000  0.000  0.000   0.000    32.50
      8      35.00    0.352    1.072    0.101    4.486    0.024    1.645    0.217  1.000  1.000  1.000  0.000  0.000   0.000    37.50
      9      40.00    0.415    1.051    0.087    4.469    0.019    1.697    0.186  1.000  1.000  1.000  0.000  0.000   0.000    42.50
     10      45.00    0.358    1.024    0.075    4.444    0.013    1.846    0.105  1.000  1.000  1.000  0.000  0.000   0.000    47.50
     11      50.00    0.343    1.001    0.069    4.436    0.011    1.841    0.186  1.000  1.000  1.000  0.000  0.000   0.000    52.50
     12      55.00    0.321    0.968    0.057    4.426    0.005    1.903    0.159  1.000  1.000  1.000  0.000  0.000   0.000    57.50
     13      60.00    0.384    0.977    0.048    4.421    0.002    2.012    0.107  1.000  1.000  1.000  0.000  0.000   0.000    62.50
     14      65.00    0.406    0.986    0.042    4.416    0.001    2.128    0.075  1.000  1.000  1.000  0.000  0.000   0.000    67.50
     15      70.00    0.483    0.985    0.039    4.416    0.001    2.257    0.119  1.000  1.000  1.000  0.000  0.000   0.000    72.50
     16      75.00    0.392    0.967    0.032    4.411   -0.002    2.442    0.079  1.000  1.000  1.000  0.000  0.000   0.000    77.50
     17      80.00    0.354    0.949    0.028    4.409   -0.004    2.494    0.046  1.000  1.000  1.000  0.000  0.000   0.000    82.50
     18      85.00    0.349    0.950    0.025    4.409   -0.005    2.552    0.047  1.000  1.000  1.000  0.000  0.000   0.000    90.00
     19      95.00    0.304    0.953    0.021    5.421   -0.004    2.713    0.051  1.000  1.000  1.000  0.000  0.000   0.000   100.00
     20     105.00    0.288    0.944    0.017    5.421   -0.004    2.856    0.056  1.000  1.000  1.000  0.000  0.000   0.000   110.00
     21     115.00    0.271    0.940    0.010    5.416   -0.002    2.948    0.050  1.000  1.000  1.000  0.000  0.000   0.000   120.00
     22     125.00    0.255    0.932    0.005    4.396   -0.001    2.996    0.051  1.000  1.000  1.000  0.000  0.000   0.000   130.00
    BASE    135.00    0.229    0.920    0.489                                              GROUND SURFACE SETTLEMENT   0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT


 ***********************************************************
   OUTPUT FOR IV02270
   WITH A PEAK ACCELERATION OF  0.37 G
   AND SLOPE = 0.00
 ***********************************************************

 ******************************************************
   MAXIMUM RESPONSE VALUES AT TOP OF OR IN EACH LAYER
 ******************************************************
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LAYER NO.   DEPTH     AMAX     VMAX     DMAXR     TIME     DFINALR  TAUMAX    CYCLIC  FINAL  FINAL  FINAL  UMAX    UFINAL SETTLE DEPTH TO
            TO TOP                                                          GAMMAX  DELTA  DETAG  DETAU                       MIDLAYER

      1       0.00    0.126    1.389    0.488    26.137    0.300    0.601    0.121  0.935  0.935  0.935  0.000  0.000   0.000     2.50
      2       5.00    0.109    1.319    0.490    26.085    0.303    1.025    0.536  0.848  0.845  0.845  0.000  0.000   0.000     7.50
      3      10.00    0.239    1.235    0.464    26.057    0.290    1.064    3.238  0.672  0.668  0.668  0.000  0.000   0.000    12.50
      4      15.00    0.423    1.428    0.110     3.254    0.043    1.173    0.190  1.000  1.000  1.000  0.000  0.000   0.000    17.50
      5      20.00    0.378    1.425    0.100     3.254    0.042    1.282    0.179  1.000  1.000  1.000  0.000  0.000   0.000    22.50
      6      25.00    0.347    1.410    0.090    25.732    0.043    1.318    0.154  1.000  1.000  1.000  0.000  0.000   0.000    27.50
      7      30.00    0.352    1.397    0.082     3.259    0.039    1.418    0.124  1.000  1.000  1.000  0.000  0.000   0.000    32.50
      8      35.00    0.335    1.376    0.076    25.727    0.037    1.523    0.190  1.000  1.000  1.000  0.000  0.000   0.000    37.50
      9      40.00    0.329    1.335    0.063     3.259    0.023    1.568    0.165  1.000  1.000  1.000  0.000  0.000   0.000    42.50
     10      45.00    0.360    1.303    0.054    24.952    0.019    1.606    0.099  1.000  1.000  1.000  0.000  0.000   0.000    47.50
     11      50.00    0.367    1.279    0.050    24.949    0.017    1.656    0.178  1.000  1.000  1.000  0.000  0.000   0.000    52.50
     12      55.00    0.415    1.237    0.043    26.030    0.017    1.681    0.133  1.000  1.000  1.000  0.000  0.000   0.000    57.50
     13      60.00    0.495    1.215    0.038    26.025    0.014    1.781    0.100  1.000  1.000  1.000  0.000  0.000   0.000    62.50
     14      65.00    0.479    1.197    0.034    25.215    0.013    1.798    0.065  1.000  1.000  1.000  0.000  0.000   0.000    67.50
     15      70.00    0.443    1.184    0.033    25.212    0.013    1.932    0.109  1.000  1.000  1.000  0.000  0.000   0.000    72.50
     16      75.00    0.442    1.162    0.027    25.207    0.010    1.971    0.066  1.000  1.000  1.000  0.000  0.000   0.000    77.50
     17      80.00    0.440    1.148    0.022    25.205    0.007    1.967    0.035  1.000  1.000  1.000  0.000  0.000   0.000    82.50
     18      85.00    0.375    1.138    0.021    25.205    0.007    2.065    0.040  1.000  1.000  1.000  0.000  0.000   0.000    90.00
     19      95.00    0.299    1.114    0.018    25.202    0.007    2.231    0.041  1.000  1.000  1.000  0.000  0.000   0.000   100.00
     20     105.00    0.269    1.086    0.013     8.539    0.004    2.350    0.046  1.000  1.000  1.000  0.000  0.000   0.000   110.00
     21     115.00    0.317    1.063    0.009    24.927    0.003    2.516    0.045  1.000  1.000  1.000  0.000  0.000   0.000   120.00
     22     125.00    0.289    1.043    0.005    24.944    0.002    2.693    0.048  1.000  1.000  1.000  0.000  0.000   0.000   130.00
   BASE     135.00    0.261    1.019    0.738                                              GROUND SURFACE SETTLEMENT   0.000

  DFINALR IS FINAL RELATIVE DISPLACEMENT WHEN SLOPE IS ZERO AND INCREASE IN FRD IF SLOPE IS GREATER IS GREATER THAN ZERO
  DMAX FOR BASE IS ABSOLUTE DISPACEMENT, OTHERS ARE RELATIVE DISPLACEMENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  1
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  2
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  3
  HISTORY OF SUSTAINED EXCESS PORE PRESSURE IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  4

  FOR SECOND COMPONENT

  HISTORY OF ACCELERATION AT TOP OF LAYER  1 IS SAVED IN OUTPUT FILE NUMBER  5
  HISTORY OF SHEAR STRESS IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  6
  HISTORY OF SHEAR STRAIN IN LAYER  7 IS SAVED IN OUTPUT FILE NUMBER  7
```