COASTAL BLUFF EVALUATION

March 14, 2019
SL11157-1

Client:
Jay and Lisa Cobb
2264 Vermont Avenue
Clovis, California
93619

Project name:
Parcel 9, North Ocean Avenue
APN: 064-481-009
Cayucos Area
San Luis Obispo County, California

Dear Mr. and Mrs. Cobb:

1.0 INTRODUCTION

This report presents the results of a geologic evaluation of the coastal bluff for the proposed bed and breakfast to be located at Parcel 9 North Ocean Avenue, APN: 064-481-009, Cayucos area, San Luis Obispo County, California. See Figure 1: Area Location Map for the general location of the project area, which was obtained from the computer program *Topo USA 8.0* (DeLorme, 2009). The purpose of this evaluation is to determine the geologic coastal bluff hazard for the property and determine the rate of bluff erosion or retreat for a 100-year period. Included in this report are recommendations for reducing site erosion and bluff loss.

1.1 Site Description

Parcel 9 North Ocean Avenue is located at 35.449703 degrees north latitude and -120.908094 degrees west longitude at a general elevation of 18 feet above mean sea level. The property is approximately square in shape and located where North Ocean Avenue intersects Lucerne Street to the west of the property. The project property will hereafter be referred to as the "Site See Figure 1: Area Location Map for the general layout of the project area.

The Site has a slight slope gradient towards the southeast. Surface drainage follows the topography towards the southeast. Annual grasses currently vegetate the Site.

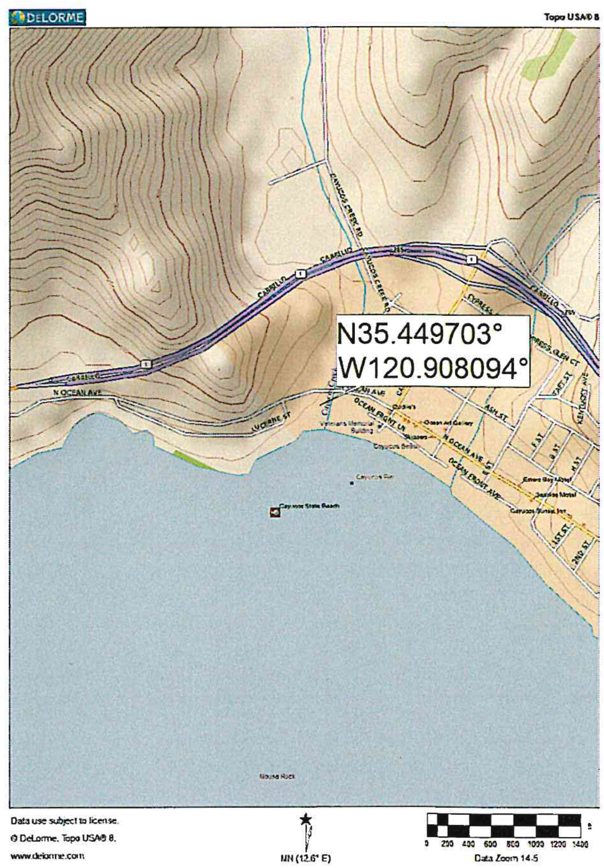

Figure 1: Area Location Map

1.2 Project Description

The size and layout of the proposed development at the Site is currently unknown. At the time of the preparation of this report, the proposed bed and breakfast is anticipated to be one or two stories in height and to be constructed using light wood framing. It is anticipated that the proposed bed and breakfast will utilize a slab-on-grade and/or raised wood lower floor system.

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2.0 PURPOSE AND SCOPE

The purpose of this evaluation is to determine the geologic coastal bluff hazard for the property and determine the rate of bluff erosion or retreat for a 100-year period. Included in this report are recommendations for reducing site erosion and bluff loss.

This report is in accordance with requirements outlined in the Establishing Development Setbacks from Coastal Bluffs (Johnsson, 2003), as well as in accordance with requirements outlined in the County of San Luis Obispo General Plan - Safety Element, adopted December 1999.

The following specific tasks were performed as part of our assessment:

1. Review of historical aerial photographs, pertinent published and unpublished geotechnical studies and literature, and geologic maps for the subject project area.

2. A field study consisting of site reconnaissance and subsurface exploration including exploratory borings in order to formulate a description of the sub-surface conditions at the Site.

3. Logging of borings and obtaining bulk soil/bedrock samples for classification and laboratory testing.

4. Laboratory testing of selected soils samples considered representative of site conditions.

5. Geologic reconnaissance mapping of the site and adjacent areas was conducted on February 22, 2019.

6. The bluff edge was defined and a numerical slope stability analysis was completed to establish a setback for slope stability for both static and pseudo-static conditions.

7. Establish a long-term bluff retreat rate.

8. Preparation of this report including findings, conclusions, and recommendations regarding engineering geology aspects of the project.

3.0 GEOLOGIC RECOMMENDATIONS

The proposed development is geologically suitable provided that the recommendations provided herein are implemented. The following are recommended for implementation at the Site.

1. The retreat rate analysis (28-feet in 100 years) and addition of the 10-foot buffer has calculated a construction setback line at the property of 38 feet. It is recommended that the setback line as depicted on Plate 1A, Site Engineering Geologic Map, be incorporated into the design.

2. The setback line as depicted on Plate 1A is recommended to be established in the field as a series of stakes prior to initiation of construction. This setback line would be the measured distance from the top of bluff as determined from the date of this report. It is understood that erosion of the bluff may occur between the period of publication of this report and construction of the building but the retreat rate analysis has considered the long-term erosion rate of the property and episodic erosion events are anticipated and are calculated within the erosion safety factors.

3. It is recommended that numerical slope stability analyses be conducted on soil or rock slopes constructed steeper than 2-to-1 (horizontal to vertical). Locally steeper slopes may be allowed depending on further study and the results of a slope stability analysis.

4. Fill slopes designed or constructed steeper than California Building Code requirements (2-to-1 horizontal to vertical) should be evaluated by a numerical slope stability analysis completed by the project soils engineer.

5. Seepage is anticipated along the interface of the surface materials and the underlying formational units. Isolated seepage within formational units should also be anticipated. Surface drainage facilities (graded swales, gutters, positive grades, etc) are recommended at the base of cut slopes that allow surfacing water to be transferred away from the base of the slope. The project designer is recommended to offer specific design criteria for mitigation of water drainage behind walls and other areas of the site. This is especially imperative upslope of retaining walls for residences. Subsurface drainage systems should not be connected into conduit from surface drains and should not connect to downspout drainage pipes.

6. It is recommended that the Engineering Geologist review the project plans prior to construction.

7. Conventional grading equipment may be used for excavations.

8. It is recommended that proposed design of the site improvements be completed by a civil engineer knowledgeable in surface drainage control.

9. Surface drainage should be controlled to prevent concentrated water-flow discharge onto either natural or constructed slopes. Surface drainage gradients should be planned to prevent ponding and promote drainage of surface water away from building foundations, edges of pavements and sidewalks or natural or man-made slopes. For soil areas we recommend that a minimum of two (2) percent gradient be maintained.

10. Excavation, fill, and construction activities should be in accordance with appropriate codes and ordinances of the County of San Luis Obispo. In addition, unusual subsurface conditions encountered during grading such as springs or fill material should be brought to the attention of the Engineering Geologist and Soils Engineer.

11. Rock rip-rap is recommended for concentrated drainage outfall locations that do not discharge onto paved or exposed rock surfaces. It is recommended that geotextile fabric (Enkamat 7010 or similar) be placed underneath the rip-rap and installed per the manufacturer's recommendations.

12. Gutters are recommended to be installed along all sloped rooflines. Gutter downspouts should not allow concentrated drainage to discharge near the residence foundations but rather should convey the water in solid piping away from the residence and toward drainage facilities.

13. The site is located within or near the 500-year flood zone based on Federal Emergency Management Agency flood zone maps. The project civil engineer is recommended to assess the potential for flooding at the proposed building location.

14. The following dust mitigation measures are recommended to be initiated at the start and maintained throughout the duration of the construction or grading activity.

    a. Construction vehicle speed at the work site must be limited to fifteen (15) miles per hour or less;
    b. Prior to any ground disturbance, sufficient water must be applied to the areas to be disturbed to prevent visible emissions from crossing the property line;
    c. Areas to be graded or excavated must be kept adequately wetted to prevent

visible emissions from crossing the property line;

d. Storage piles must be kept adequately wetted, treated with a chemical dust suppressant, or covered when material is not being added to or removed from the pile;
e. Equipment must be washed down before moving from the property onto a paved public road; and
f. Visible track-out on the paved public road must be cleaned using wet sweeping or a HEPA filter equipped vacuum device within twenty-four (24) hours.

4.0 ENGINEERING GEOLOGY

4.1 Regional Geology

The Site is located in the vicinity of the San Luis Range of the Coast Range Geomorphic Province of California. The Coast Ranges lie between the Pacific Ocean and the Sacramento-San Joaquin Valley and trend northwesterly along the California Coast for approximately 600 miles between Santa Maria and the Oregon border.

Regionally, the Site is located on the Cambria block composed of a large, thick block of Cretaceous age sediments that are surrounded by Franciscan Formation rocks. The Cambrian Slab extends from the Los Osos fault south of the property and northward to San Simeon Creek to the north.

4.2 Local Geology

Locally, the site is located within Franciscan Complex as depicted on Plate 1, Site Engineering Geology Map. DeLattre, 2016 mapped the Site as underlain by Cretaceous age Franciscan Complex (Kfm) units. Information derived from subsurface exploration was used to classify subsurface soil and formational units and to supplement geologic mapping.

4.2.1 Fill

Artificial fill was mapped throughout the majority of the Site. A maximum of 12 feet of fill was encountered within Borings B-2 and B-3. Based on historical photographs, it appears that fill was placed on the site between the 1953 and 1972 photographs, possibly during the grading of the mobile home park across North Ocean Avenue. The fill encountered within the borings and observed along the bluff face consisted of light gray sand with gravel and boulders of serpentinite.

4.2.2 Alluvial Deposits

Alluvial deposits were encountered throughout the site. Younger alluvial deposits were mapped along the base of the east bluff in the current Cayucos Creek channel. Older alluvial deposits were encountered within Borings B-2 and B-3 underlying the fill. These alluvial deposits are associated with the historical Cayucos Creek channel. The alluvial deposits were observed to consist of gray sand and silt observed to be loose and moist to saturated.

4.2.3 Franciscan Complex

Dibblee, 2006 and DeLattre, 2016 map the Site as within Franciscan Complex (KJm). DeLattre, 2016 describes the Franciscan Complex as "Melange-Chaotic mixture of fragmented, fault-bounded, metamorphosed rock masses embedded in a penetratively sheared matrix of argillite and crushed metasandstone...Individual rock masses range from less than a meter to kilometers in scale and include altered mafic volcanic rock (greenstone), chert, serpentinite, high-grade blueschist, greywacke, and conglomerate." The Franciscan Complex was mapped throughout the site and was encountered within all borings. The Franciscan Complex at the site was observed to consist of dark gray to olive green claystone observed to be massive, highly fractured, moderately hard and moderately weathered. Boring logs are presented in Appendix A.

4.3 Surface and Ground Water Conditions

Surface drainage follows the topography southwest. Surface drainage should be directed away from proposed structures and slopes. No springs or seeps were observed at the project. Groundwater was encountered within the borings at a depth of 26 feet below ground surface.

4.4 Active Faulting and Coseismic Deformation

The Alquist-Priolo Earthquake Fault Zoning Act passed in 1972 requires that the State Geologist establish Earthquake Fault Zones around the surface traces of active faults and to issue appropriate maps. The closest Earthquake Fault Zone is on a section of the Hosgri Fault Zone located approximately 9.5 miles northwest of the Site. The subject site is not located within an Earthquake Fault Zone (Jennings, 2010)

Table 1: Distance and Moment Magnitude of Closest Faults

Closest Active Faults to Site	Approximate Distance (miles)	Moment Magnitude (Mw)
Los Osos Fault	9.5	7.5
Hosgri Fault	15.0	6.8
San Andreas	40.0	6.9

The closest known active portion of a Holocene age fault is an active portion of the Hosgri Fault Zone that is located approximately 9.5 miles northwest of the Site (Jennings, 2010). Plate 3 is a Regional Fault Map for the area. The San Andreas fault is the most likely active fault to produce ground shaking at the Site although it is not expected to generate the highest ground accelerations because of its distance from the Site.

4.5 Landslides

Dibblee, 2006 and DeLattre, 2016 did not map landslides in the vicinity of the property. During site mapping and review of aerial photography, landslides were not observed at the Site. There appears to be a low potential for landslide to affect the proposed development. Plate 4 presents an aerial photograph. There is a low rockfall potential to affect the proposed residence based on the lack of boulders upslope of the proposed development.

4.6 Flooding and Severe Erosion

The bluff portion of the site is located within the 500-year flood zone based on Federal Emergency Management Agency flood zone maps (FEMA, 2012).

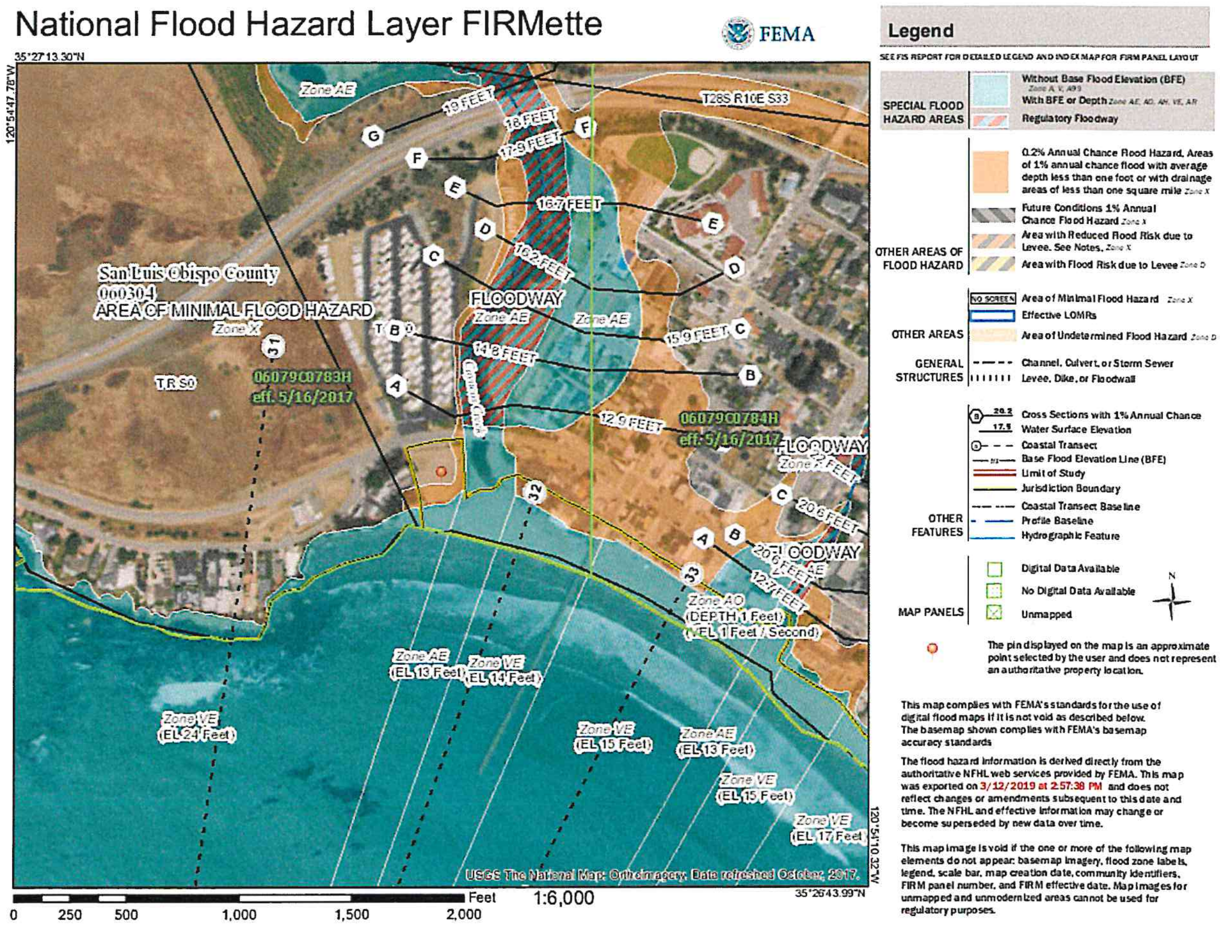

Figure 2: Area Flood Map

The surficial and formational deposits are subject to erosion where not covered with vegetation or hardscape. The potential for severe erosion is considered low provided that vegetation and erosion control measures are implemented immediately after the completion of grading.

4.7 On-site Septic Systems

No septic systems are proposed. It is our understanding that the project will utilize a community sewer system.

4.8 Hydrocollapse of Alluvial Fan Soils

The potential for hydrocollapse of subsurface materials is considered low due to the absence of alluvial fan material at the Site.

5.0 SISMOLOGY AND CALCULATION OF EARTHQUAKE GROUND MOTION

5.1 Seismic Hazard Analysis and Structural Building Design Parameters

Estimating the design ground motions at the Site depends on many factors including the distance from the Site to known active faults; the expected magnitude and rate of recurrence of seismic events produced on such faults; the source-to-site ground motion attenuation characteristics; and the Site soil profile characteristics. According to section 1613 of the 2016 CBC (CBSC, 2016), all structures and portions of structures should be designed to resist the effects of seismic loadings caused by earthquake ground motions in accordance with the *ASCE 7: Minimum Design Loads for Buildings and Other Structures*, hereafter referred to as ASCE7-10 (ASCE, 2013). The Site soil profile classification (Site Class) can be determined by the average soil properties in the upper 100 feet of the Site profile and the criteria provided in Table 20.3-1 of ASCE7-10.

Spectral response accelerations, peak ground accelerations, and site coefficients provided in this report were obtained using the computer-based Seismic Design Maps tool available from the Structural Engineers Association of California (SEAOC, 2018). This program utilizes the methods developed in ASCE 7-10 in conjunction with user-inputted Site location to calculate seismic design parameters and response spectra (both for period and displacement) for soil profile Site Classes A through E.

Site coordinates of **35.449703** degrees north latitude and **-120.908094** degrees east longitude were used in the web-based probabilistic seismic hazard analysis (SEAOC, 2018). Based on the results from the in-situ tests performed during the field investigation, the Site was defined as **Site Class D**, "Stiff Soil" profile per ASCE7-10, Chapter 20. Relevant seismic design parameters obtained from the program area summarized in Table 2: Seismic Design Parameters.

Table 2: Seismic Design Parameters

Site Class	D, "Stiff Soil"
Seismic Design Category	D
1-Second Period Design Spectral Response Acceleration, S_{D1}	**0.443g**
Short-Period Design Spectral Response Acceleration, S_{DS}	**0.797g**
Site Specific MCE Peak Ground Acceleration, PGA_M	**0.473g**

6.0 LIQUEFACTION

Due to the densities within the sub-surface material and the presence of clays in the subsurface, the liquefaction potential at the Site is considered low.

7.0 COASTAL HAZARDS

7.1 Bluff Erosion and Retreat Process

Bluff erosion and sea cliff retreat along the central coast of California is generally controlled by a combination of factors including: rock type, geologic structure, soil type, bluff height, direction and magnitude of wave attack, coastline configuration, surf zone profile, amount of surface runoff over bluff tops, degree of water seepage, and other adverse man-made conditions. The effects of erosive agents acting on the bluff are greater on weaker rock types or soils.

The principal causes of sea cliff erosion and retreat along the bluff-top include the forces of natural erosion and weathering of the colluvium and artificial fill and wave attack concentrated at the base of the bluff. Static and Intrinsic sea cliff erosion are on-going active processes that act upon sea cliff bluffs. Static erosion is a process whereby a loss of soil strength is exacerbated through increased pore water within the soil. This is seen as surficial instability and rock falls within a sea cliff. This process is controlled by the availability of surface and subsurface water to the face of the sea cliff.

Soil deposits tend to fail by slumping when they become over-weighted by precipitation during winter seasons and when there is no support from underlying sediments. Less significant erosional agents involved in bluff erosion include direct impact of precipitation on the cliff face, runoff down the cliff face, and sapping and winnowing of soils in areas of ground-water seepage.

Bluff erosion at the Site is also based upon the ability of the soil deposits to resist wave attack. Storm surge coupled with large wave activity acts to weaken, dislodge, or even remove sections of the soil deposits. Wave energy, especially winter storm wave activity, exacerbates erosion.

Intrinsic erosion is a process of rock and soil weathering due to chemical reaction with available water. This is the process that accounts for loosening, spalling, flaking, granulation, and pulverization of the fill due to cycles of wet-dry, alkali-acid, and heat-cold conditions. Intrinsic weathering is the cause of soil breakdown, resulting in accumulation of slope wash debris along bluff faces.

Other parameters involving erosion include geologic units, bluff geometry, wave action, coastal configuration, surface drainage, and seismicity. The following is a brief discussion of the factors and how they relate to the subject area.

7.1.1 Surficial Drainage

In the current state, surficial drainage is directed toward the bluff top and acts as one of the primary mechanisms for bluff erosion. Accelerated rates of cliff erosion will occur along the bluff top as long as surficial drainage is unchecked. Surface drainage from the top of bluff should be directed to surface drainage inlets via onsite drains and pipes. Development usually reduces the amount of erosion of the bluff.

7.1.2 Coastal Configuration

The predominant wave direction along the Central California coastline is from the northwest during the spring, summer, and fall months. During the winter months, wave direction can either be from the northwest or southwest, depending upon the source of the current offshore storm. As this area faces south, it would be expected to receive wave action from southern storms.

7.1.3 Seismicity

The Site, like all other sites in the general area, can be affected by moderate to major earthquakes centered on one of the known large Holocene age active faults listed in Table 1. The maximum moment magnitudes are expressed, although any event on these faults could result in moderate to severe ground shaking at the subject property. Ground shaking can weaken bluff material. Material within the bluff may become dislodged and may tumble due to a seismic event. Due to the long interval between seismic events, the long-term retreat rate would not be substantially affected.

7.2 Bluff Retreat Rates

The bluff within the study area is actively eroding and is expected to continue to retreat. A historic bluff retreat rate for the Site based upon a reliable aerial photograph evaluation was completed. Our evaluation required site-specific research, with an established rate based upon the actual data interpretation by a Certified Engineering Geologist with experience and knowledge of coastal processes and local bluff conditions.

An aerial photogrammetric investigation was conducted to determine the long-term retreat rate of the bluff in the vicinity of the proposed residence. The existing bridge on North Ocean Avenue appears in the 1953 aerial image; aerial photography was determined to be the best option to determine bluff erosion through time.

7.3 Aerial Photograph Analysis

The North Ocean Avenue bridge in the immediate vicinity of the subject property in the 1953 images were measured and compared to present day measurement to obtain a scale of the photos. The distance to the bluff edge from the residence in the images was then compared with the present distance to determine the rate of retreat. It is recognized that there is a limit to accuracy involved in the procedure of measuring the images. Clarity, exact bluff location, and lack of features add to uncertainty in defining the bluff edge. Limits of accuracy of the interpretation of the bluff edge is recognized with the addition of a buffer (in this case 10 feet) to the bluff retreat rate and conservative (rounding up) values used in calculations.

The width of the bridge was measured as 36 feet wide in year 2019. The bridge in the 1953 aerial photo is measured as 5.5/60th ticks or 6.5 feet per 60th tick.

The current distance from the centerline of North Ocean Avenue (along the western property boundary, east of the existing rip rap) to the top of bluff was measured with a measuring tape in the field. This distance was 235 feet (also as measured on Plate 1). The distance from the bluff top to the centerline of North Ocean Avenue was also measured on the aerial image (date 1953). This distance was 39/60th of an inch (or 253.5 feet). The calculation used to obtain the retreat rate was:

> The historical distance from top of bluff to centerline of North Ocean Avenue is 253.5 feet minus the current distance from top of bluff to centerline of North Ocean Avenue is 235 feet.
>
> 253.5 feet – 235 feet = 18.5 feet (222 inches) of erosion during the time period from 1953 to 2019 (66 years).
>
> This equates to a retreat rate of 3.36 inches per year (28 feet in 100 years).

According to Johnsson (2003), total development setbacks should include an additional buffer, generally 10 feet, that serves to allow for uncertainty in aspects of the analysis, allows for future increase in bluff retreat due to sea level rise, and assures that at the end of the design life of the structure that the foundation is not being undermined. An additional setback to the 100-year retreat rate would be the greater of either a 10-foot buffer or a slope stability analysis that shows instability greater than 10 feet. The numerical slope stability analysis (as described in Section 9.1) shows that the bluff maintains a factor of safety of 1.5 or greater and that the greater of the two additional setbacks is the 10-foot buffer. A total setback for the house is 38 feet, which is the addition of the 100-year retreat rate (28 feet) plus the 10-foot buffer. This 38-foot total setback line is depicted on Plate 1, Site Engineering Geology Map.

Figure 3: Aerial Photograph – 1972 (Kenneth & Gabrielle Adelman)

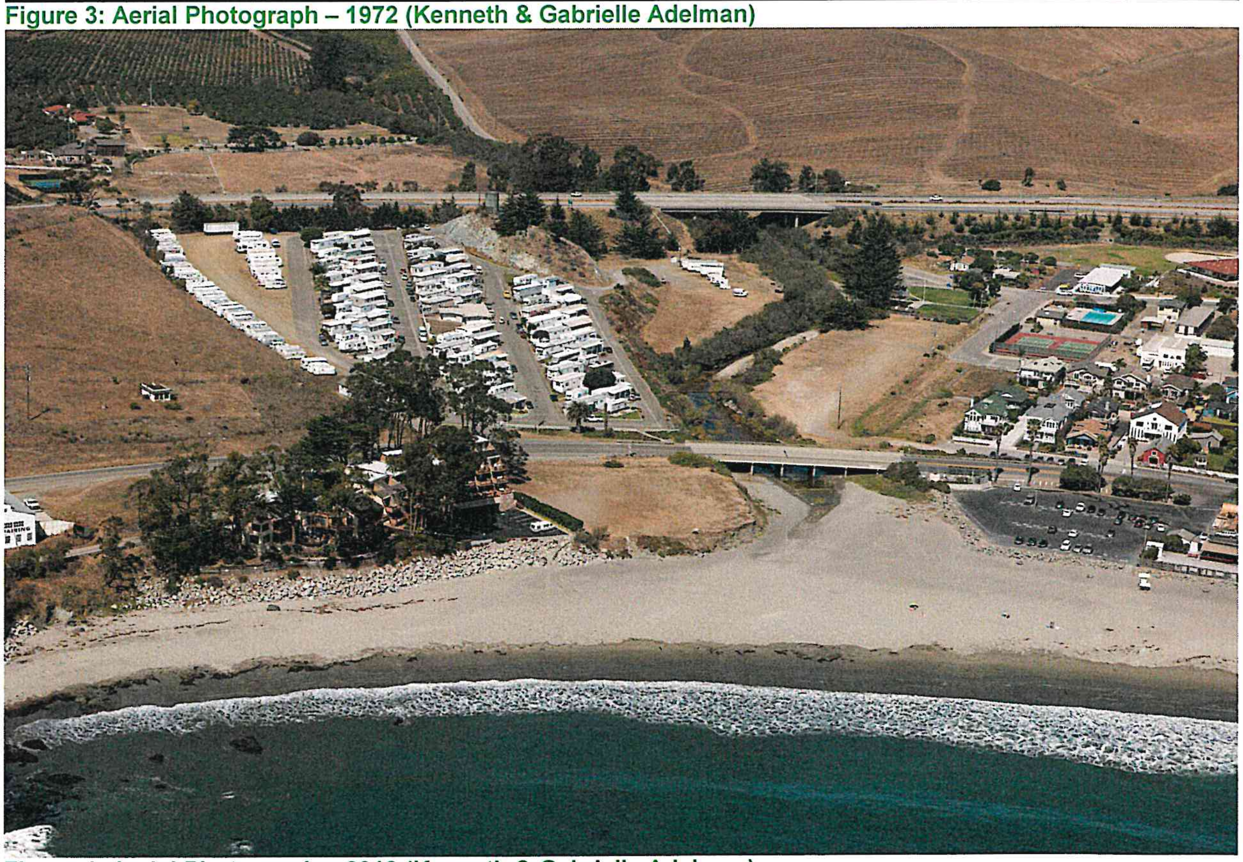

Figure 4: Aerial Photograph – 2010 (Kenneth & Gabrielle Adelman)

7.4 Tsunamis and seiches

Tsunamis and seiches are two types of water waves that are generated by earthquake events. Tsunamis are broad-wavelength ocean waves and seiches are standing waves within confined bodies of water, typically reservoirs. PG&E, 1988 reported that the historical record for San Luis Obispo County includes no tsunamis that have exceeded the normal tidal range. PG&E, 1988 suggests that faulting on the offshore area could generate tsunami wave height as great as six feet. The Tsunami Inundation Map for Emergency Planning (CAL E.M.A., 2009) maps the tsunami potential along the bluff face southwest of the proposed development.

The San Luis Obispo County Safety Element states "the worst case scenario would occur if a tsunami occurred during a meteorological high tide (storm surge) which would add an estimated 14.5 feet to the runup values... thus with a worst case scenario, the estimated tsunami runup for the 100-year and 500-year events would be approximately elevation 24 and 39 feet above mean sea level, respectively" (San Luis Obispo County Department of Planning and Building, 1999). However, a latitude specific analysis (Houston and Garcia, 1978) is more accurate for the site when compared to the general tsunami runup elevations presented in the referenced Safety Element for the County of San Luis Obispo (San Luis Obispo County Department of Planning and Building, December 1999). Based on the latitude of the site, the estimated tsunami runup for the 100-year and 500-year events would be approximately elevation 5 and 7 feet above mean sea level. Based on a bluff height of 20 feet elevation, the potential for a 100-year and 500-year seismic water wave event to affect the proposed building area is still considered low. There is a low potential for seismically induced flooding due to the location of the property from a reservoir.

8.0 NUMERICAL SLOPE STABILITY ANALYSIS

As required in Establishing Development Setbacks from Coastal Bluff (Johnsson, 2003), "The analyses should demonstrate a factor of safety greater than or equal to 1.5 for static condition and greater than or equal to 1.1 for the seismic condition." The bluff located along the southern property line was analyzed to determine whether the existing coastal bluff meets the minimum requirements for slope stability. One profile was modeled utilizing SLOPE/W, a computer-modeling program. Profile A-A' traverses the Site in an approximate north to south direction; refer to Plate 1 for approximate location of profile. The location of Boring B-1, B-2 and the top of bluff are approximately depicted on the profile.

The stability analysis was performed utilizing the subsurface materials observed during boring operations. General modeling conditions included: 1) approximately 12 feet of fill overlying Alluvial Deposits (Qoa); 2) underlying Franciscan Complex (Kfm); and 3) groundwater at a depth of 26 feet below ground surface. The Engineering Geologist determined the final profile by studying surface geologic conditions, geologic maps, and observations made during the field investigation.

The purpose of the numerical slope stability analysis was to determine the horizontal distance from the top of the bluff to the back of the potential slip surface for a factor of safety of 1.5 for static conditions and 1.12 for psuedo-static conditions. As the slope may be affected by seismic events, a dynamic loading condition was applied to the existing slope (pseudo-static conditions). As stated in *Guidelines for Evaluating and Mitigating Seismic Hazards in California* (CDMG, 1997), "In California, many state and local agencies, on the basis of local experience, require the use of a seismic coefficient of 0.15, and a minimum computed pseudo-static factor of safety of 1.0 to 1.2 for analysis of natural, cut, and fill slopes. Basic guidelines for making preliminary evaluations of embankments to ensure acceptable performance...were:

Table 3: Horizontal Distance from Top of Bluff to Potential Slip Surfaces

Profile	Factor of Safety	
	Static	Pseudo-Static
Profile A-A	1.90	1.29

using a pseudo-static coefficient of 0.10 for magnitude 6.5 earthquakes and 0.15 for magnitude 8.25 earthquakes, with an acceptable factor of safety of the order of 1.15." Calculations for pseudo-static numerical analysis within these iterations utilized a seismic coefficient of 0.15 g.

The potential slip surfaces for static and psuedo-static conditions (based on a factor of safety of 1.5 for static and 1.1 for pseudo-static) are presented on Figure 5 and 6. The respective factor of safety values are presented in Table 3.

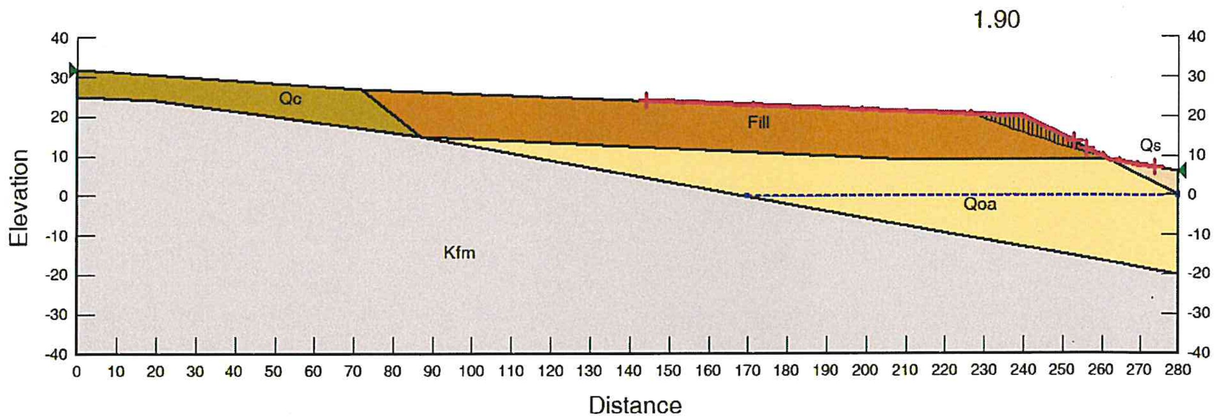

Figure 5: Section A-A (static)

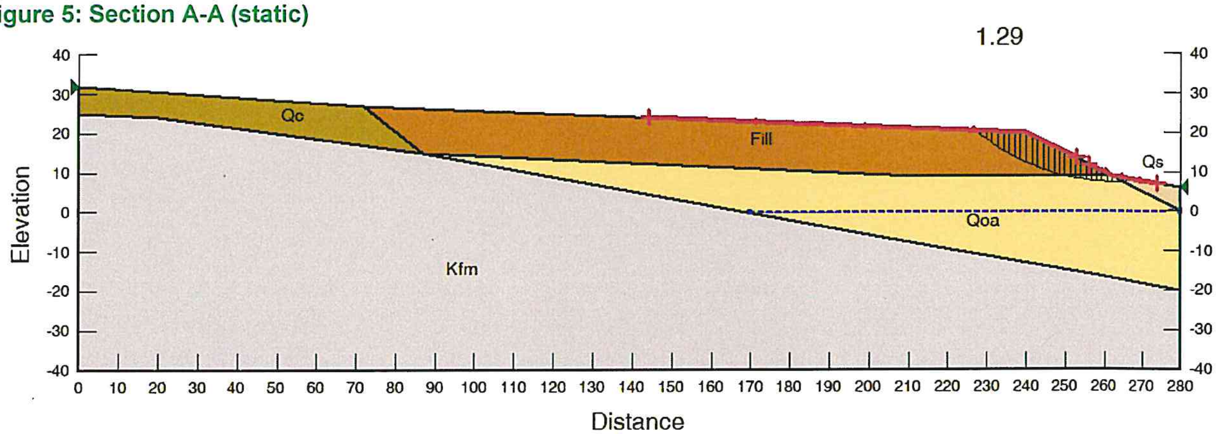

Figure 6: Section A-A (seismic)

The horizontal distance from the top of bluff to the potential slip surface for both static and psuedo-static conditions is less than the required 10-foot buffer distance. Therefore, a 10-foot buffer from the top of bluff (in addition to the 100-year bluff erosion rate) appears to be the most conservative setback for new development on the subject property.

9.0 HAZARDS FROM GEOLOGIC MATERIALS

9.1 Expansive Soils

The potential for expansive soil at the Site is medium based on laboratory testing in the Soils Engineering Report (GeoSolutions, Inc., 2019), expansion index of 62. The foundation recommendations for expansive soils should be incorporated into the design.

9.2 Naturally Occurring Asbestos

There is a moderate potential for natural occurring asbestos to be present at the property due to the presence of Franciscan Complex units. Naturally occurring asbestos is associated with serpentinite rock units within the Franciscan Complex. Serpentinite boulders were observed within bluff face.

Testing can be performed to verify the presence/absence of naturally occurring asbestos. In lieu of testing, an Asbestos Health and Safety Program and Asbestos Dust Mitigation Plan should be developed in accordance with Air Pollution Control District.

9.3 Radon and Other Hazardous Gases

The potential for radon or other hazardous gases is low due to the absence of Monterey Formation formational units and other identified radon producing formations.

10.0 GRADING OPERATIONS, CUT AND FULL, SUBDRAINS

Based on the depth of Franciscan Complex units encountered at the site, it is anticipated that the foundations will be excavated into engineered fill. Conventional grading equipment may be used for excavations. The Soils Engineering Report provides additional foundation and construction recommendations. Based on the field investigation, subdrains are not anticipated at this time, however this may be reevaluated at the time of construction.

Construction inspections and testing during all grading and excavating operations should be performed by the project Soils Engineer/Engineering Geologist. Section 1705.6A of the 2016 CBC (CBSC, 2016) requires the following inspections by the Soils Engineer/Engineering Geologist as shown in Table 4: Required Verification and Inspections of Soils:

Table 4: Required Verification and Inspections of Soils

Verification and Inspection Task	Continuous During Task Listed	Periodically During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.	-	X
2. Verify excavations are extended to proper depth and have reached proper material.	-	X
3. Perform classification and testing of controlled fill materials.	-	X
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of controlled fill.	X	-
5. Prior to placement of controlled fill, observe sub-grade and verify that site has been prepared properly.	-	X

11.0 ADDITIONAL SERVICES

The recommendations contained in this report are based on exploratory borings and on the continuity of the sub-surface conditions encountered. It is assumed that GeoSolutions, Inc. will be retained to perform the following services:

1. Consultation during plan development.
2. A preliminary plan review regarding the locations of proposed improvements and development once grading and drainage plans are available.
3. Final plan review of final grading and drainage documents prior to construction.
4. Additionally, construction observation by the Engineering Geologist and/or Soils Engineer may be necessary to verify sub-surface conditions during excavation activities.

5. Final grading report and as-built map in accordance with County Guidelines for Engineering Geology Reports, Item 29 (San Luis Obispo County Department of Planning and Building, 2016).

12.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report are based upon the assumption that the soil conditions do not deviate from those disclosed during our study. Should any variations or undesirable conditions be encountered during the development of the Site, GeoSolutions, Inc. should be notified immediately and GeoSolutions, Inc. will provide supplemental recommendations as dictated by the field conditions.

This report is issued with the understanding that it is the responsibility of the owner or his/her representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project, and incorporated into the project plans and specifications. The owner or his/her representative is responsible to ensure that the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they are due to natural processes or to the works of man on this or adjacent properties. Therefore, this report should not be relied upon after a period of 3 years without our review nor should it be used or is it applicable for any properties other than those studied. However many events such as floods, earthquakes, grading of the adjacent properties and building and municipal code changes could render sections of this report invalid in less than 3 years.

Thank you for the opportunity to have been of service in preparing this report. If you have any questions or require additional assistance, please feel free to contact the undersigned at (805) 543-8539.

Sincerely,
GeoSolutions, Inc.

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PLATES

1"=40'
Scale

LEGEND:
Fill - Fill
Qs - Beach Sand Deposits (Holocene Age)
Qya - Alluvial Deposits (Holocene to Pleistocene Age
Kfm - Franciscan Complex (Late Cretaceous Age)
- Boring Locations
- Cross Section
- Contact (Dashed where approx.)

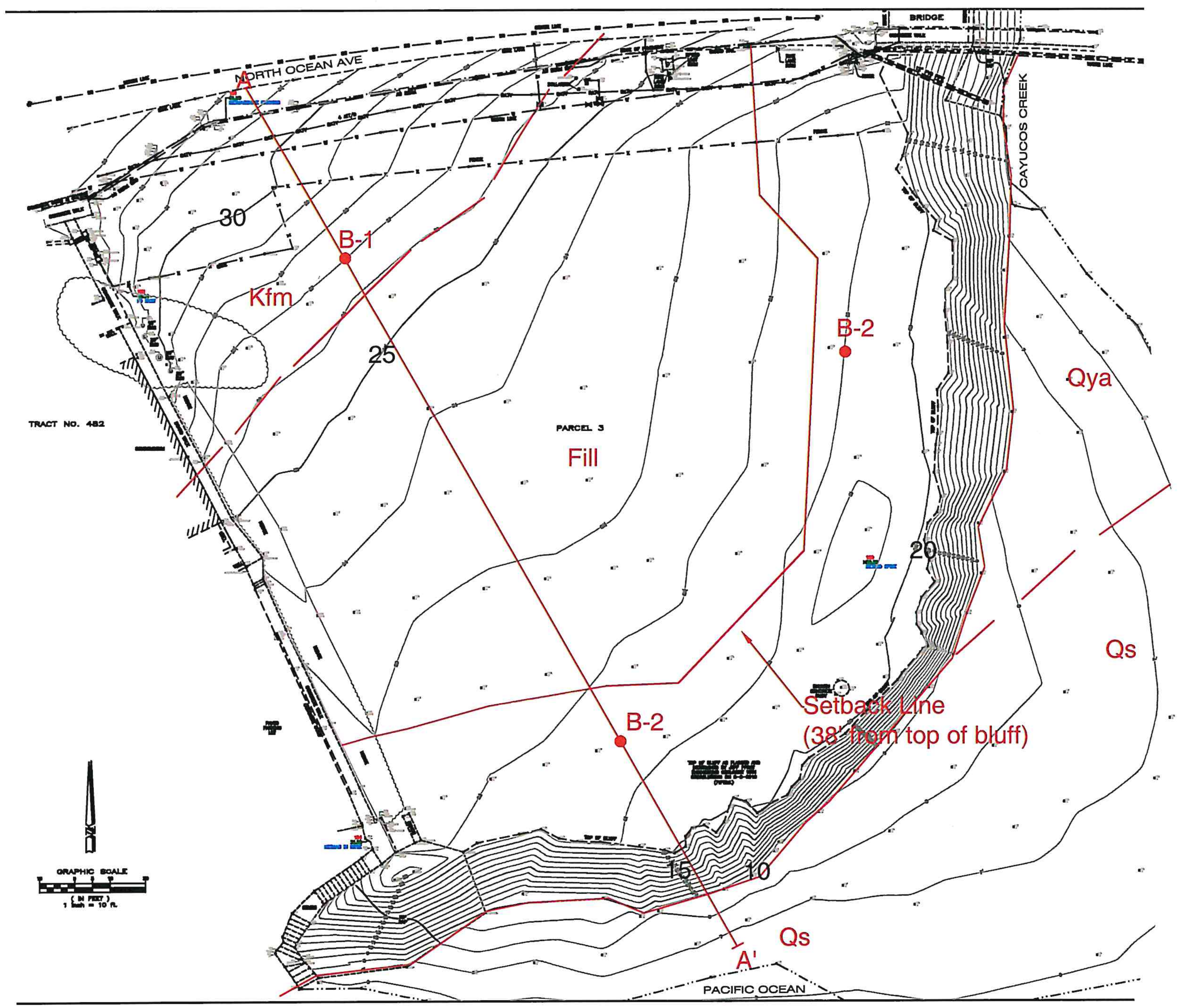

PLATE
1A

PROJECT
SL11157-1

SITE ENGINEERING GEOLOGY MAP

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

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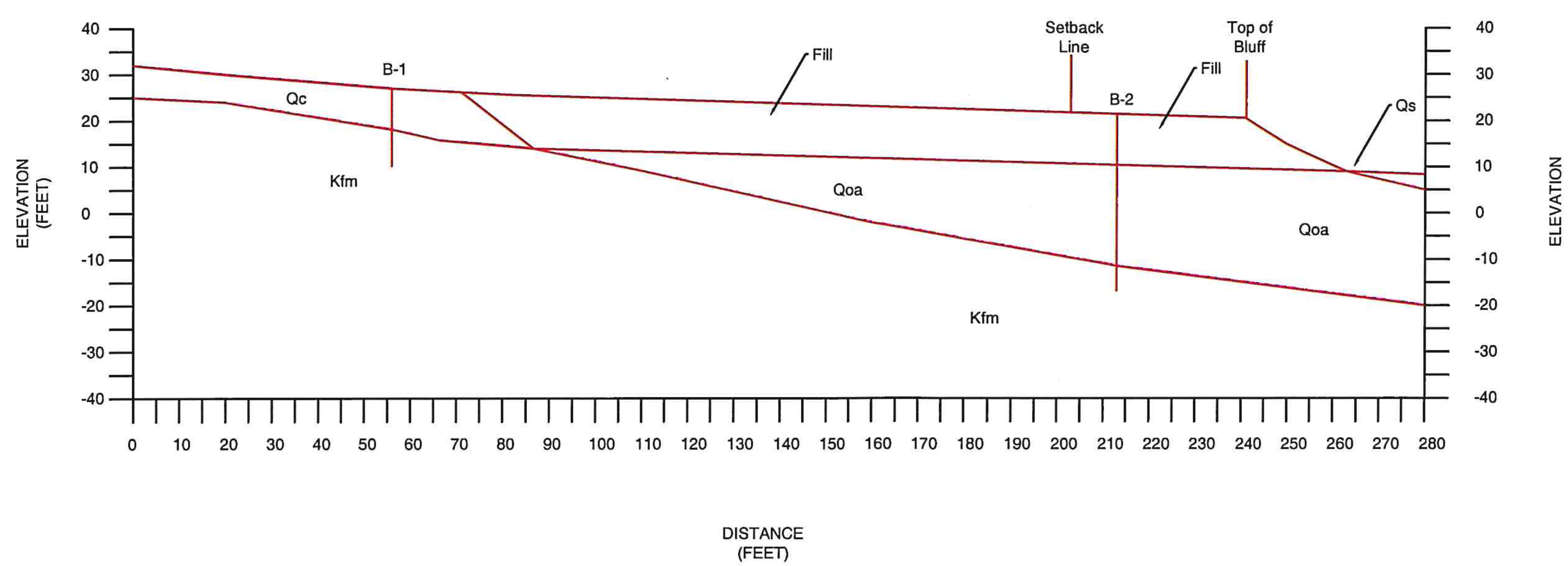

1"= 40'
Scale

LEGEND:
Fill - Fill
Qc - Colluvium
Qs - Beach Sand Deposits (Holocene Age)
Qoa - Alluvial Deposits (Holocene to Pleistocene Age
Kfm - Franciscan Complex (Late Cretaceous Age)

PLATE 1B

PROJECT SL11157-1

SITE CROSS SECTIONS

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
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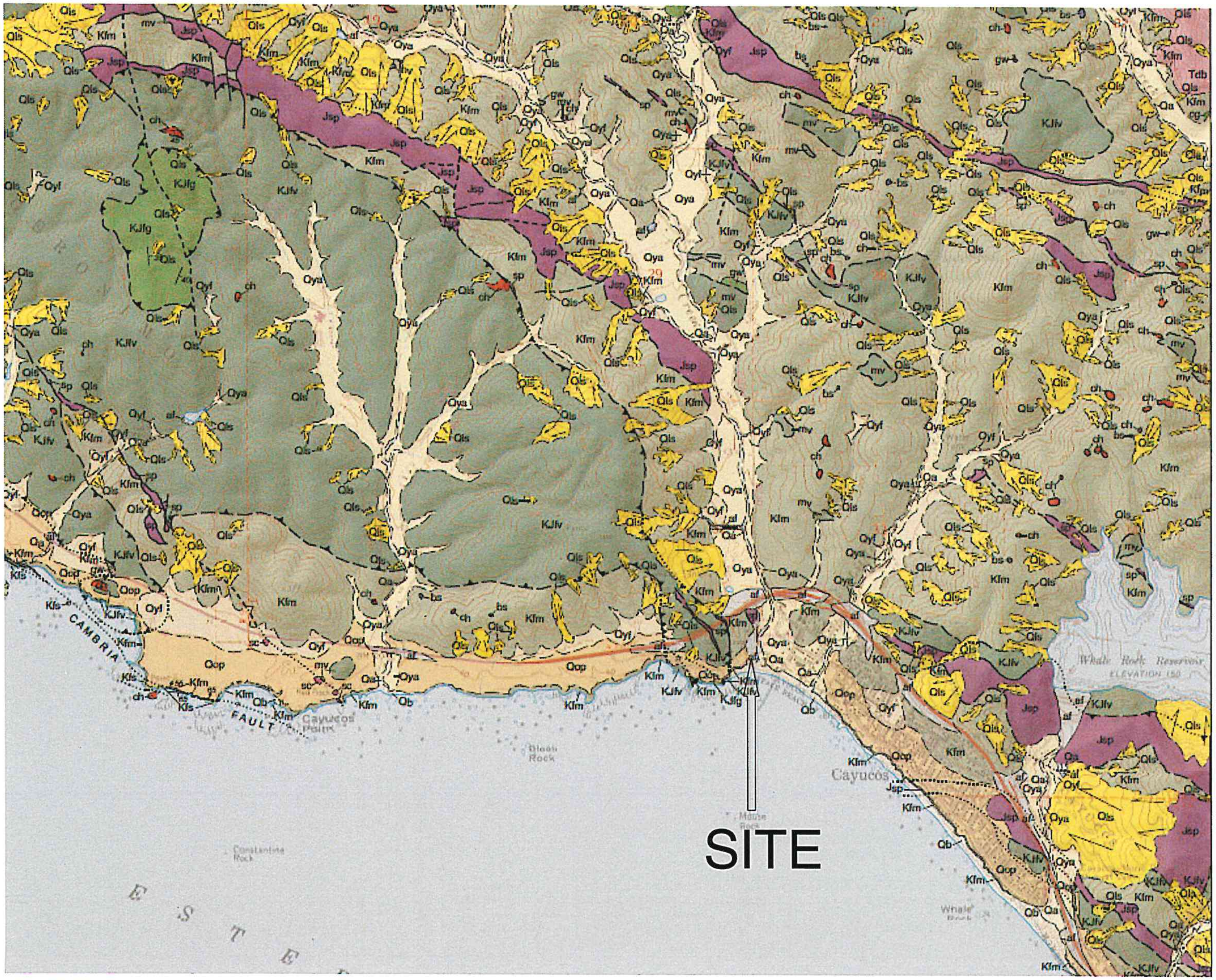

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REGIONAL GEOLOGIC MAP
(Delattre, 2016)

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
2A

PROJECT NO:
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DESCRIPTION OF MAP UNITS

SURFICIAL UNITS

af — **Artificial fill (Historic)**—Mapped locally, primarily larger highway fills and embankment dams for lakes.

Qb — **Beach and dune deposits (late Holocene)**—Unconsolidated, mostly fine- and medium-grained sand accumulated along the coastline; includes scattered cobbles.

Qa — **Alluvial flood plain and channel deposits (late Holocene)**—Active stream channel and recently active flood-plain deposits. Consist of unconsolidated, silty sand and sandy gravel with cobbles, scattered boulders, and occasional lenses of silty clay.

Qls — **Landslide deposits (Holocene to late Pleistocene)**—Includes comparatively shallow earth flow and debris slide deposits consisting of fragmented bedrock and soil mixtures; also deeper rock slides consisting of relatively intact bedrock displaced along rotational or translational slip surfaces.

Qya — **Young alluvial flood-plain deposits, undivided (Holocene to late Pleistocene)**—Unconsolidated sand, silt, and clay-bearing alluvium deposited on flood-plains and along valley floors. Surfaces on young deposits are undissected and lack soil development. Surfaces on older deposits are slightly dissected and display weak soil development.

Qyf — **Young alluvial fan deposits (Holocene to late Pleistocene)**—Unconsolidated gravel, sand, silt, and clay-bearing alluvium deposited in characteristic fan-shaped morphology on terraces and floodplains at the mouths of steep drainages with fan.

Qoa — **Old alluvial flood-plain deposits (late Pleistocene)**—Fluvial sediments preserved above active flood plains and channels. Consist of weakly-consolidated silty sand and sandy gravel with cobbles. Terrace surfaces preserved along drainages are slightly dissected and capped by moderately- to well-developed pedogenic soils.

Qop — **Old paralic deposits (late Pleistocene)**—Marine terrace deposits consisting of beach and nearshore sands and gravels, commonly containing fossils and shell fragments; nearly everywhere covered by colluvium and alluvial fan deposits included as part of map unit. These deposits rest on an emergent wave-cut platform preserved by regional uplift. At two locations northwest of the town of Cayucos the wave-cut platform has been dated at approximately 120 ka (Hanson and others, 1994).

TERTIARY ROCKS

Tdb — **Diabase and basalt (middle Miocene)**—Dark olive-gray, fine- to medium-grained, spheroidally weathered, diabase and basalt. Occurs as sills and dikes in the Rincon shale. Locally exhibits weakly developed pillow structure.

Tr — **Rincon Shale (early Miocene and Oligocene)**—Dark brown to orange-brown siltstone and silty claystone, poorly- to well-bedded, weathers white to light brown. Locally contains zones of dolomite. Lithologically similar to rocks that have been assigned to the lower part of the Monterey Formation but contains fossils known to be older (Hall and Prior, 1975).

Tf — **Cambria Felsite (Oligocene)**—Light gray and grayish orange crystalline felsite, commonly flow-layered with phenocrysts of quartz and plagioclase. Includes some soft, white tuff. Forms resistant ridges and volcanic plug-like masses (Hall and others, 1979).

BASEMENT COMPLEXES

Franciscan Complex

Kfm — **Mélange (Late Cretaceous)**—Chaotic mixture of fragmented, fault-bounded, metamorphosed rock masses embedded in a penetratively sheared matrix of argillite and crushed metasandstone. Penetrative deformation of the matrix postdates metamorphism of enclosed rock masses. Individual rock masses range from less than a meter to kilometers in scale and include altered mafic volcanic rocks (greenstone), chert, serpentinite, high-grade blueschist, graywacke, and conglomerate. Greenstone, chert, and serpentinite blocks are probably derived from the Coast Range Ophiolite and were emplaced and interleaved in the matrix during subduction. Small pods mapped locally are designated with abbreviated labels as follows:

mv – metavolcanic rock

sp – serpentinite

ch – chert

bs – blueschist

gw – graywacke

cg – conglomerate

Larger slabs and blocks enclosed in mélange consist of the following:

Kfs — **Sandstone of Cambria (Late Cretaceous)**—Light gray, orange-brown weathering, medium- to thick-bedded, fine- to coarse-grained arkose and arkosic wacke. In places interbedded with brown to black siltstone with locally abundant biotite and carbonaceous debris. Unit is more coherent and less sheared and fractured than other Franciscan units. Contains Late Cretaceous foraminifera and pollen (Graymer and others, 2014). This unit has also yielded detrital zircons of about 80–90 Ma (Chapman and others, 2016).

KJfg — **Graywacke and metagraywacke (Cretaceous and Jurassic?)**—Brown to greenish gray, fine- to medium-grained, massive- to thin-bedded graywacke sandstone interbedded with shale and siltstone. Crops out as fault-bounded slabs and blocks in mélange. Composed of 60% to 70% quartz, 20% to 30% feldspar, 5% biotite, and 10% shale fragments embedded in a muddy matrix (Hall and Prior, 1975). Rocks are generally moderately to intensely sheared, often obscuring original stratification. Locally includes conglomerate beds with clasts of chert, sandstone and metavolcanic rock. Exotic blocks characteristic of mélange are absent or rare.

KJfv — **Mafic metavolcanic rocks (greenstone) (Cretaceous? and Jurassic)**—Primarily metamorphosed basalt and diabase. Includes massive to pillowed basalt flows, breccia, and minor tuff. Typically deeply weathered and extensively sheared. Commonly associated with pods of contorted ribbon chert and slivers of chert too small to distinguish at map scale. Considered to be tectonic blocks incorporated into mélange derived from the upper part of Jurassic ophiolite.

KJfc — **Chert (Cretaceous and Jurassic)**—Red and green radiolarian chert and metachert associated with mafic volcanic rocks. Commonly veined and recrystallized, locally bleached to yellow or white. Deposited in deep oceanic setting prior. Locally interbedded with thin layers of argillite.

Great Valley Complex - Coast Range Ophiolite

Jsp — **Serpentinized Ultramafic Rocks (Jurassic)**—Pervasively sheared serpentinite occurring as lenticular fault-bounded bodies in Franciscan mélange. Considered to be dismembered bodies of the Coast Range Ophiolite tectonically interleaved with mélange during subduction and entrained along faults. Locally altered to:

sc — **Silica-carbonate rock**—Hydrothermally altered serpentinite, composed of quartz and carbonate mineral assemblages. Relatively resistant, outcropping as craggy knobs.

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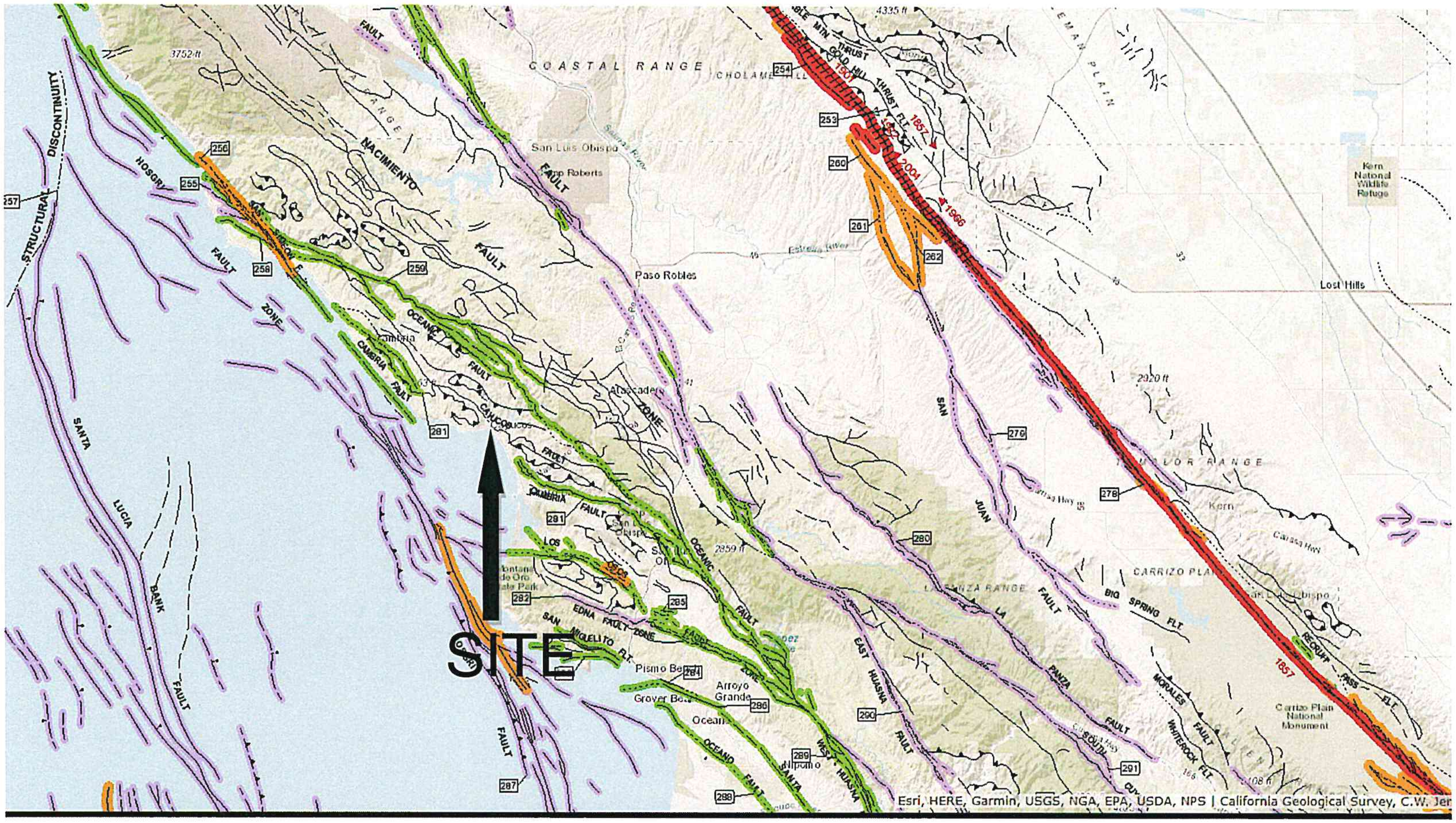
REGIONAL GEOLOGIC EXPLANATIONS

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
2B

PROJECT NO:
SL11157-1



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REGIONAL FAULT MAP
(Jennings, 2010)

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
3

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AERIAL PHOTOGRAPH
(Google, 2018)
PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
4

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HISTORICAL AERIAL PHOTOGRAPH (1953)

PARCEL 9, NORTH OCEAN AVENUE, APN: 064-481-009
CAYUCOS AREA, SAN LUIS OBISPO COUNTY, CALIFORNIA

PLATE
5

PROJECT NO:
SL11157-1

APPENDIX A

Boring Logs

GEO SOLUTIONS

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Phone: 805-614-6333
201 S. Milpas St, Ste 103, Santa Barbara, CA 93103
Phone: 805-966-2200

BORING LOG

BORING NO. **B-1**
JOB NO. **SL11157-2**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	**Parcel 9, North Ocean**	DRILL RIG:	**CME 55**
DRILLING LOCATION:	**See Figure 3**	HOLE DIAMETER:	**8 Inches**
DATE DRILLED:	**February 22, 2019**	SAMPLING METHOD:	**SPT and CA**
LOGGED BY:	**JAP**	APPROX. ELEVATION:	**Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **15 Feet**

DEPTH	LITHOLOGY	USCS	SOIL DESCRIPTION	SAMPLE ID	SAMPLERS TYPE	BLOWS/ 12 IN	N 1/60	MOISTURE CONTENT (%)	FINES CONTENT (%)	PLASTICITY INDEX (PI)	EXPANSION INDEX (EI)	OPTIMUM WATER CONTENT (%)	MAXIMUM DRY DENSITY (pcf)	COHESION, C (psf)	FRICTION ANGLE, (degrees)
0–1		CL	SANDY CLAY: very dark grayish brown, slightly moist												
1–5		CL	SANDY CLAY: black, slightly moist												
2				A					57.8	32	62	12.4	120.0		
4			very stiff	CA		23	30							544	25.3
5–8		CL	SANDY CLAY: light gray, slightly moist												
6				B											
8–15			CLAYSTONE: gray to light brown, moderately hard, highly fractured, moderately weathered, slightly moist, Franciscan Complex (Kfm)												
9				CA		73	77							1409	9.7
12				C						25		10.4	127.6		
13			hard												
14				SPT		38	54								
15–20															

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BORING LOG

BORING NO. **B-2**
JOB NO. **SL11157-2**

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	**Parcel 9, North Ocean**	DRILL RIG:	**CME 55**
DRILLING LOCATION:	**See Figure 3**	HOLE DIAMETER:	**8 Inches**
DATE DRILLED:	**Febuary 22, 2019**	SAMPLING METHOD:	**SPT**
LOGGED BY:	**JAP**	APPROX. ELEVATION:	**Not Recorded**

Depth of Groundwater: **26 Feet** Boring Terminated At: **35 Feet**

DEPTH	LITHOLOGY	USCS	SOIL DESCRIPTION	SAMPLE ID	SAMPLERS TYPE	BLOWS/ 12 IN	N 1/60	MOISTURE CONTENT (%)	FINES CONTENT (%)	PLASTICITY INDEX (PI)	EXPANSION INDEX (EI)	OPTIMUM WATER CONTENT (%)	MAXIMUM DRY DENSITY (pcf)	COHESION, C (psf)	FRICTION ANGLE, (degrees)
0		SM	SILTY SAND: light brown, with gravel and cobbles of sepentinite, loose, fill												
2				D					9.3	N.P.	0				
3		SM	SILTY SAND: light gray, moist, medium dense												
4				SPT		11	22								
7			(fill) 1" layer of black CLAY with brick												
9			medium dense	SPT		9	14								
12		SM	SILTY SAND: light gray, slightly moist												
14				SPT		13	18								
15			(alluvium) medium dense												
19				SPT		12	14								
25			saturated												
26			(groundwater)												
32			CLAYSTONE: dark gray to olive green, moderately hard, slightly moist, highly fractured, moderately weathered, Franciscan Complex (Kfm)												
34				SPT		31	28								
35–37															

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BORING LOG

BORING NO. B-3
JOB NO. SL11157-2

PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	**Parcel 9, North Ocean**	DRILL RIG:	**CME 55**
DRILLING LOCATION:	**See Figure 3**	HOLE DIAMETER:	**8 Inches**
DATE DRILLED:	**February 22, 2019**	SAMPLING METHOD:	**CA and SPT**
LOGGED BY:	**JAP**	APPROX. ELEVATION:	**Not Recorded**

Depth of Groundwater: **Not Encountered** Boring Terminated At: **30 Feet**

DEPTH	LITHOLOGY	USCS	SOIL DESCRIPTION	SAMPLE ID	SAMPLERS TYPE	BLOWS/ 12 IN	N 1/60	MOISTURE CONTENT (%)	FINES CONTENT (%)	PLASTICITY INDEX (PI)	EXPANSION INDEX (EI)	OPTIMUM WATER CONTENT (%)	MAXIMUM DRY DENSITY (pcf)	COHESION, C (psf)	FRICTION ANGLE, (degrees)
0–5		SM	SILTY SAND: light brown, slightly moist												
			medium dense	CA		9	12								
5–12		SC	CLAYEY SAND: dark brown, slightly moist												
				SPT		5	8								
			(fill) medium dense												
12–28		SM	SILTY SAND: dark gray, slightly moist												
			(alluvium)												
				SPT		3	4								
			loose												
28–30			CLAYSTONE: dark gray to olive green, slightly moist, heavily fractured, moderately soft, moderately weathered, Franciscan Complex (Kfm)	SPT		23	21								