GEOTECHNICAL INVESTIGATION

Yerba Buena Road Distress
Ventura County Public Works Agency
Ventura County, California

Prepared for:

Mr. Daniel Espinoza

Roads and Transportation Department

VENTURA COUNTY PUBLIC WORKS AGENCY

800 South Victoria Avenue #1600

Ventura, California 93009

April 2025

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April 29, 2025
SC6164

Mr. Daniel Espinoza
Roads and Transportation Department
VENTURA COUNTY PUBLIC WORKS AGENCY
800 South Victoria Avenue #1600
Ventura, California 93009

SUBJECT: **Geotechnical Investigation**
RE: Yerba Buena Road Distress
Ventura County, California

Dear Mr. Espinoza:

Cotton, Shires and Associates, Inc. (CSA) is pleased to present **Ventura County Public Works Agency (County)** with this geotechnical investigation for the proposed roadway distress repairs along Yerba Buena Road in unincorporated Ventura County, California. Geotechnical engineering services for this project were provided in accordance with our proposal dated October 4. 2024, and authorized under Agreement No. AE25-018 (County Project No. P6050666) dated October 21, 2024. We prepared a previous draft report dated April 1, 2025. CSA subsequently received review comments on the draft report from the County, and our responses and comment resolutions are included in this final report.

In this report, we characterize the geotechnical conditions underlying the four (4) sites, or mile post (MP) locations, along Yerba Buena Road to develop geotechnical recommendations and design criteria for repair alternatives.

We appreciate the opportunity to be of continued service to you on this project. If you have any questions regarding this report, please feel free to contact us.

Sincerely,

COTTON, SHIRES AND ASSOCIATES, INC.

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GEOTECHNICAL INVESTIGATION
YERBA BUENA ROAD DISTRESS
Ventura County, California

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Ventura County, California

1.0 INTRODUCTION

Cotton, Shires and Associates, Inc. (CSA) is pleased to present **Ventura County Public Works Agency (County)** with this geotechnical investigation for the proposed Yerba Buena Road Distress project in southeastern Ventura County, California.

1.1 Project Description

The project consists of geotechnical evaluation of the observed pavement distress, i.e. tension and/or extension cracks and/or roadway settlement, at four (4) mile post (MP) locations along Yerba Buena Road, along with the presentation of pavement and slope repair alternatives. Based on our site reconnaissance and discussions with County staff, we understand that the proposed pavement and slope repairs will need to be evaluated at mile posts (MP) 0.93, 1.94, 2.61 and 2.96 along Yerba Buena Road.

We understand that other geotechnical studies conducted along Yerba Buena Road, for similar County road conditions, have included slope repair alternatives such as fill slope restoration, h-piles and lagging, and soil nail retaining walls.

During our September 26, 2024, site visit with you, we observed distressed pavement at each site, possible downslope failures or slumps at MP 1.94 and 2.96, tension cracks along the top of the descending slopes, and possible mapped landslides upslope and downslope of MP 1.94, all of which may impact the level of effort required to evaluate the suitability of slope repair alternatives at each site. General project site limits are delineated on Figure 1 – Site Vicinity Map.

1.2 Purpose and Scope of Work

The purpose of our investigation was to explore and generally characterize the earth materials at each of the four (4) mile post (MP) locations, evaluate potential hazards including erosion, settlement, slope creep, landslides and seismic geohazards, and to develop preliminary geotechnical design recommendations and design criteria for subsequent design concept(s) and roadway repair plans (by others). A summary of the work performed is outlined below.

1.2.1 Research and Review of Available Data – We researched, reviewed and compiled data from available historic aerial photographs and published and readily available documents to gain background data regarding previous site uses (if any) and geotechnical conditions.

1.2.2 Pre-Field Planning and Coordination – Prior to subsurface exploration at the four (4) mile post locations, we performed a site reconnaissance to locate and mark the exploration locations. Subsequently we contacted Underground Service Alert (USA) for underground utility clearance and applied for/obtained an encroachment permit from the County.

1.2.3 Geologic Mapping – A compilation of readily available geologic mapping and data was prepared for the site area from regional geologic maps (Dibblee 1992; Weber, 1973). Geologic mapping was performed within the project limits on December 16, 2024, and during the subsurface exploration work in January 2025. Regional geology is presented on Figure 2 – Regional Geologic Map. Regional landslide maps are presented on Figures 3a and 3b – Landslide Inventory Map. Individual geologic maps and engineering geologic cross-sections depicting the distribution of earth materials and structural data within each of the four (4) mile post (MP) locations are presented on Figures 4a/4b through 7a/7b – Geologic Map and Geologic Cross-Section, respectively.

1.2.4 Subsurface Exploration – CSA conducted a subsurface exploration program, consisting of a combination of small-diameter (8”) hollow-stem auger boring and hand-dug (24” by 36”) test pits, in January 2025. We completed the following at each of the four (4) mile post (MP) locations:

- MP 0.93 – two borings (B-9 and B-10) and two test pits (TP 04 and TP 05)
- MP 1.94 – two borings (B-1 and B-2) and one test pit (TP 03)
- MP 2.61 – three borings (B-6, B-7 and B-8) and two test pits (TP 01 and TP 02)
- MP 2.96 – three borings (B-3, B-4 and B-5)

The borings at MP 1.94 were drilled on January 6, 2025, utilizing a truck-mounted GT8 drilling rig provided by 2R Drilling, Inc. of Chino, California. The borings at MP 0.93, 2.61 and 2.91 were drilled on January 13 and 14, 2025, utilizing a track-mounted CME 55 drilling rig provided by 2R Drilling, Inc. The borings ranged in depth from about 9 to 47 feet below ground surface (bgs). The exploratory test pits were excavated on January 20 and 21, 2025, utilizing hand labor provided by Mike’s Excavating Service of Temecula, California. The test pits ranged in depth from about 5 to 6½ feet below ground surface (bgs). Summaries of field exploration procedures and boring and test pit logs are presented in Appendix A – Field Exploration.

1.2.5 Geotechnical Laboratory Testing – Laboratory tests were performed on selected disturbed and undisturbed soils samples obtained from the borings and test pits. Laboratory tests consisted of moisture content, wet and dry unit weight determinations, particle size analysis, #200 sieve wash analysis, Atterberg limits, direct shear strength, triaxial strength, maximum unit weight/optimum moisture content, expansion index, and general corrosion properties (resistivity, pH, sulfates and chlorides). The results of the laboratory testing program are presented in Appendix B – Laboratory Testing, and on our boring/test pit logs in Appendix A.

1.2.6 Geotechnical Evaluation and Reporting – Geotechnical evaluation at each of the four (4) sites consisted of characterizing field and laboratory test data and developing conclusions and recommendations regarding geotechnical and seismic hazards, excavatability and temporary excavation stability, and foundation type and design criteria. Based on data obtained from our subsurface exploration and geotechnical laboratory testing programs, we have formulated geotechnical opinions regarding site conditions and geotechnical hazards, and recommendations for the proposed improvements, including opinions regarding:

- Soil and groundwater conditions at each site;
- Site seismicity, and liquefaction and landslide potential;
- Seismic design parameters based on the 2022 California Building Code;
- Site preparation and grading and compaction requirements for fill placement below/behind structures and within other proposed development areas;
- Temporary excavations;
- Evaluation of onsite materials for use as compacted fill;
- Construction considerations including excavatability of the onsite materials;
- H-Pile and lagging;
- Preliminary pavement sections; and
- General corrosion potential of soil encountered in foundation and utility areas (limited soil chemistry testing: pH, resistivity, chloride and sulfate content)

2.0 SITE CONDITIONS

2.1 Surface Conditions

2.1.1 Regional Surface Conditions – The four (4) project site are located along Yerba Buena Road, a two-lane asphalt concrete roadway with an average width of twenty feet (20’) located near the Pacific Ocean and the Ventura/Los Angeles County line in South Coast region of Ventura County. At its southern end, where it intersects Pacific Coast Highway, the first segment of Yerba Buena Road ascends 3.28 miles to its intersection with Cotharin Road. Yerba Buena Road is located in relatively steep terrain along the southern flank of the western Santa Monica Mountains. The generally north-south trending roadway, created through conventional cut/fill grading, is located along the eastern, relatively steep flank of the Little Sycamore Canyon drainage. Elevations within the project area ranges from approximately +300 feet at mile post (MP) 0.93 to approximately +1000 feet at mile post (MP) 2.96. The roadway and drainage primarily traverse marine sedimentary rocks, with relatively minor amounts of intrusive and interbedded volcanic rocks.

At MP 0.93, slopes descend from the western (southbound) margin of the roadway approximately ninety to one hundred feet (90′-100′) toward Yerba Buena (i.e. Little Sycamore) Creek at gradients ranging from 1.5:1 (33°) to 1:1 (45°). A twenty-to-twenty-five-foot (20′-25′) high, relatively steep (50°-55°) cut slope is present above the east (northbound) side of the road. Natural slopes continue to ascend approximately fifty-five to eighty feet (55′-80′) to the crest of a southwest-trending ridgeline at gradients ranging to 1.5:1 (33°) to 1:1 (45°).

At MP 1.94, slopes descend from the north (southbound) margin of the roadway approximately sixty to sixty-five feet (60′-65′) toward Yerba Buena (i.e. Little Sycamore) Creek at gradients ranging from 1.75:1 (30°) to, adjacent to the creek flowline, 1:1 (45°). Along the south (northbound) side of the roadway, slopes ascend approximately five hundred to five hundred twenty-five feet (500′-525′) to a saddle and crest of a prominent east-west trending ridgeline at gradients ranging to 1.5:1 (33°) to 1:1 (45°).

At MP 2.61, slopes descend from the western (southbound) margin of the roadway approximately sixty to sixty-five feet (60′-65′) toward Yerba Buena (i.e. Little Sycamore) Creek at gradients ranging from 1.75:1 (30°) to 1:1 (45°), and locally as steep as 53° along the Yerba Buena Creek flowline. An approximately twenty-foot (20′) high, relatively steep (50°-55°) cut slope is present above the east (northbound) side of the road. Natural slopes continue to ascend approximately three hundred fifty feet (350′) to the crest of a prominent south to southwest-trending ridgeline at gradients ranging to 1.5:1 (33°) to 1:1 (45°).

At MP 2.96, slopes descend from the western (southbound) margin of the roadway approximately sixty to seventy feet (60′-70′) toward Yerba Buena (i.e. Little Sycamore) Creek at gradients ranging from 1.5:1 (33°) to 1:1 (45°). An approximately fifteen to twenty-foot (15′-20′) high, relatively steep (50°-55°) cut slope is present above the east (northbound) side of the road. Natural slopes continue to ascend approximately three hundred twenty feet (320′) to a grade break along the nose of an east-west trending spur ridge at gradients ranging to 1.5:1 (33°) to 1:1 (45°).

Following our record request, the County provided CSA with several documents, including an as-built plan set, dated August 27, 2020, for pavement resurfacing along Yerba Buena Road – South. In addition to miscellaneous drainage (catch basin, v-ditch, downdrains, culverts, etc.) improvements, the as-built plans indicate that this stretch of roadway was provided with a 2" thick asphalt concrete overlay.

2.1.2 Site-Specific Roadway and Slope Distress

The following was observed and noted at MP 0.93:

- Discontinuous, sub-linear to arcuate cracking along the graded dirt shoulder and western portion of the southbound travel lane, with the majority of this distress occurring between borings B-9 and B-10 (see Figure 4a). Roughly located in the center of the distressed area is a section of pavement, shoulder and embankment that has broken and vertically dropped approximately six to twelve inches (6"-12"), as measured along the top-of-slope.

- Evidence of relatively recent, relatively thin and localized slope failures was observed in the ascending slopes along the east side of the roadway. This includes instability in colluvium at the northern end of the County-provided mapping, where field mapping and logging of boring B-9 (Figure 4a) indicate the presence of an inactive, deeper landslide feature.

- Also observed just north of topographic mapping is pronounced, discontinuous and relatively linear cracks along the top of the descending roadway embankment. These cracks have occurred in what appears to be recent spill fill along the top of the roadway embankment.

The following was observed and noted at MP 1.94:

- Closely spaced, discontinuous, sub-linear to arcuate cracking along the graded dirt shoulder and western portion of the southbound travel lane between borings B-1 and B-2 (see Figure 5a). Some of the cracks have been previously patched and continue to open up, with evidence of both vertical/lateral offset and possible roadway settlement observed.

- Evidence of relatively recent, relatively thin and localized slope failures was observed in the ascending slopes along the east side of the roadway.

- Just north of a power pole and survey control point 3007 (see Figure 5a), outside the topographic survey limits, we observed an approximately fifty foot (50′) long linear crack, with vertical and lateral offset, along the top-of-slope embankment.

The following was observed and noted at MP 2.61:

- Discontinuous, sub-linear to arcuate cracking along the top-of-slope and western portion of the southbound travel lane from south of survey control point 3009, and just outside the topographic survey mapping, north to boring B-6 (see Figure 6a). Some of the cracks have been previously patched and continue to open, with evidence of vertical/lateral offset and possible roadway settlement observed.

- Evidence of relatively recent, relatively thin and localized slope failures was observed in the ascending slopes along the east side of the roadway.

- Twelve feet (12′) of earth fill was encountered in boring B-7. Along with our field mapping of the embankment slope below, this suggests a past slope failure and repair. None of the miscellaneous as-built documents provided indicate a previous repair in this area.

The following was observed and noted at MP 2.96:

- At the southern end of the survey mapping limits, the roadway embankment, edge of pavement and metal beam guard is locally undermined as a result of recent slumping within the surficial materials (fill and soil/colluvium), between borings B-3 and B-5 (see Figure 7a). Across the road, slumping and/or surficial failure(s) has occurred in colluvial materials on the ascending slope. Review of Google Earth® imagery indicates that these failures occurred during the 2023 winter rains.

- Occasional discontinuous, sub-linear to arcuate cracking along the top-of-slope and western portion of the southbound travel lane within the topographic survey mapping limits.

- Evidence of relatively recent, relatively thin and localized slope failures was observed in the ascending slopes along the east side of the roadway.

2.2 Geologic Setting

2.2.1 Regional Geology – The subject site is located within the western Santa Monica Mountains which are part of the Transverse Ranges geomorphic province. The Santa Monica Mountains are the southwestward most of the east-trending Transverse Ranges of southern California, extending from the Oxnard Plain approximately 80 kilometers west to the Los Angeles River. The Hollywood-Santa Monica and Malibu Coast fault zones form the southern boundary of the Transverse Ranges in this area. The Transverse Ranges geomorphic province consists of generally tightly folded Mesozoic and Cenozoic marine and non-marine sedimentary strata, extending from the Santa Ynez and San Gabriel Mountains on the north, the San Andreas Fault on the east, the Santa Monica Mountains (including the Santa Barbara Channel) on the south, to offshore west of Point Arguello (including the Santa Barbara Channel). The active tectonic stress environment acting upon this region since the late Tertiary consists of regional north-south oriented oblique transpression that has produced the characteristic east-west structural grain, and the series of east-west trending ranges and valleys within the province.

The western Santa Monica Mountains, including all four (4) project locations along Yerba Buena Road "South", are underlain by a thick accumulation of lower and middle Miocene marine sedimentary and volcanic rocks (Dibblee, 1988, 1990). Specifically, the project limits are underlain by early to middle Miocene sedimentary bedrock of the Lower Topanga Formation and occasional interbeds of volcanic rocks of the middle Miocene Conejo Volcanics. In many places the Topanga is injected by diabase sills and dikes of middle Miocene age (Dibblee, 1988). Yerkes and Campbell (1979) mapped the sediments underlying the project limits as the Encinal Member of the Topanga Formation, which they describe as chiefly relatively weak, dark gray siltstone or silty mudstone which is commonly platy to shaly with a dominant conchoidal fracture. Natural outcrops of the fine-grained Topanga sediments are rare. These formations have been uplifted and deformed (gently folded) as a result of crustal compression and movement on regional fault systems, including the Hollywood-Santa Monica-Malibu Coast fault zones on the south.

The Lower Topanga Formation (aka Encinal Member of the Topanga Formation per Yerkes and Campbell, 1979) encountered in the project limits consists of interbedded brown to gray brown to gray siltstone, laminated siltstone and shale, with occasional beds of buff to brownish yellow to light gray fine-grained sandstone. The shale and siltstone beds are generally laminated to thinly bedded, slightly hard grading to hard, and highly to pervasively fractured. All of these bedrock units of the Lower Topanga Formation are considered rippable with heavy earth moving equipment but, as a combination of the bedding, hardness and fracturing, caving is likely in large-diameter borings or drilled shafts.

Where observed/mapped in the roadway cuts and along the Yerba Buena creek channel at MP 2.94, the Conejo Volcanics Formation consists of brown to olive brown (weathered) to dark gray to black basalt which is fine-grained, slightly to moderately hard and massive to vaguely bedded.

Several significant-sized landslides within the Lower Topanga Formation are identified or queried on regional geologic maps within and near the limits of the four (4) project areas (Dibblee, 1990, California Division of Mines and Geology, 2002), and relatively smaller, previously unmapped or unrecognized landslides were identified by CSA through a combination of field mapping, subsurface exploration and aerial photo/topographic map interpretation. As shown on the enclosed Landslide Inventory Map (Figure 3a), the project at MP 0.93 is located just south of two (2) historically active landslides, as mapped by the State, and our subsurface investigation and field mapping indicates that landslide-affected materials extend onto the northern portion of the mapping/repair limits.

The project located at MP 1.94 is shown within the suspected (questionable, 50% confidence) limits of large inactive landslide complex and on the northern margin of a smaller, inactive landslide mapped with 75% confidence (Figure 3a). Our field mapping and subsurface exploration has confirmed the presence of landslide-affected materials at MP 1.94, and both to the north and south of MP 1.94. Further, landslide deposits were encountered in the subsurface and mapped at the northern end of the MP 2.61 project limits, and a slump affecting the roadway embankment was mapped at MP 2.96 (see Figures 7a and 7b). Landslide-affected materials within the four (4) project limits are depicted on Figures 4a through 7a.

2.2.2 Geologic Structure – With regard to the regionally mapped geologic structure, the four (4) project areas are located on the northern and southern limb of a significant regional anticlinal fold which trends through Yerba Buena Road at approximately MP 1.5 (Sequit Anticline of Dibblee, 1990); thus, regional geologic maps depict gentle to moderately steep north- and south-dipping bedding structure within the Lower Topanga Formation. Bedding within the Topanga Formation sediments mapped at MP 0.94 dips gently southward, while bedding at the MP 2.61 and 2.94 project locations dips gently northward. Hence, our site-specific mapping is generally consistent with the regional (Dibblee, 1990) trends. Small faults with minor dip-slip displacements (both normal and reverse slip) were observed within the bedrock mapped along cut slopes.

2.3 <u>Subsurface Conditions</u>

Subsurface conditions encountered during the field exploration program across the four (4) project sites generally consisted of artificial fill, natural soil and/or colluvium, and/or landslide deposits underlain by Lower Topanga Formation bedrock. On average, one to four and a half feet

(1-4½′) of artificial fill, primarily associated with past cut/fill grading to construct the roadway, was encountered in each of the borings and test pits, with twelve feet (12′) of artificial fill encountered in boring B-7. As previously mentioned, relatively thick landslide deposits were encountered in borings at three (3) of the project locations: boring B-9 at mile post (MP) 0.93, borings B-1 and B-2 at MP 1.94, and boring B-6 at MP 2.61.

2.3.1 Artificial Fill (Af) – Artificial fill (Af) generally consisted of a matrix of fine-grained silty sand to sandy silt to sandy clay and clayey, sandy silt/clayey silt with scattered to abundant rock fragments which is slightly moist to moist to slightly to moderately compact.

2.3.2 Natural Soil (Qs) / Colluvium (Qc) – Surficial natural soil (Qs) and/or colluvium (Qc) consists of clayey sand and sandy silt with scattered small rock fragments which is medium brown, slightly moist to moist, and loose or medium stiff with scattered roots and rootlets.

2.3.3 Landslide Deposits (Qls) – Where encountered in the borings, landslide deposits within the four (4) project areas generally consist of a of silty sand to sandy silt (matrix) with scattered to abundant siltstone and sandstone fragments which is light to medium brown, dry to moist, medium dense/dense to medium stiff/stiff. In general, these deposits are massive and relatively heterogeneous, vary from matrix- to clast-supported and locally grade with depth to sheared, highly to pervasively fractured, occasionally slickensided and highly weathered siltstone and clayey siltstone. Augering into these materials was challenging, particularly at MP 1.94. Difficult and slow augering, with the potential for sloughing and/or caving, should be anticipated at times during the drilling of cast-in-drilled-hole (CIDH) pile foundation excavations.

2.3.4 Lower Topanga Formation (Ttlc) – Bedrock of the Lower Topanga Formation (Ttlc) was encountered in most explorations. Formation materials consisted of predominantly thin- to medium-bedded layers of moderately weathered, closely fractured siltstone, clayey siltstone, shale and fine-grained sandstone. Occasional thin beds of hard to very hard semi-siliceous siltstone were interspersed within the section explored. In general, weathering gradually decreased with depth while hardness inversely increased.

2.4 Groundwater Conditions

Across the four (4) project sites, no static groundwater was encountered to the maximum depth explored of 47 feet bgs. A review of historical high groundwater reported in the CDMG Seismic Hazards Zone Report for the Triunfo Pass quadrangle (CDMG, 2002) does not indicate the presence of a "Historically Shallow Groundwater Level" in the vicinity of the project sites. Given that the project sites are located approximately sixty feet (60′) above the Yerba Buena Creek channel and underlain at relatively shallow depths by bedrock, with the exception of MP 1.94, it is unlikely that high static groundwater will negatively impact the project.

3.0 SEISMICITY

Seismicity evaluation for the project consisted of the assessment of earthquake hazards such as seismic setting and nearby faults, CBC seismic design criteria and estimated strong ground motion, as summarized below.

3.1 Seismic Setting and Nearby Fault Sources

The western Santa Monica Mountains is located in a very seismically active area. Historically, this area has been subjected to strong seismic ground shaking from major earthquakes and will continue to experience strong ground shaking in the future. The Malibu Coast fault zone is the closest controlling fault to MP 0.93 (about 1.60 kilometers from the project site). None of the four sites are located within an Alquist-Priolo Earthquake Fault Zone (APEFZ).

3.2 2022 CBC/ASCE/SEI 7-16 Seismic Design Criteria

Based on our geotechnical investigation, the site locations, our interpretation of the 2022 CBC and ASCE 7 Hazards Report for ASCE 7-16 related to Earthquake Loads and using the online tool, Table 1 below provides the parameter recommendations from the corresponding figures and tables. The ASCE 7 Hazards Report for each site is presented in Appendix C – Seismic Design Parameters.

Table 1. ASCE/SEI 7-16 Seismic Design Criteria

Site	Parameter	Value
MP 0.93	Site Classification	C
	Mapped Spectral Acc. 0.2 Sec. (g)	S_S= 1.491
	Mapped Spectral Acc. 1 Sec. (g)	S_1 = 0.521
	$S_{MS} = F_a*S_s$	1.789
	$S_{M1} = F_v*S_1$	0.771
	$S_{DS} = 2/3*S_{MS}$	1.193
	$S_{D1} = 2/3*S_{M1}$	0.514
	PGA_M	0.722
MP 1.94	Site Classification	C
	Mapped Spectral Acc. 0.2 Sec. (g)	S_S= 1.484
	Mapped Spectral Acc. 1 Sec. (g)	S_1 = 0.521
	$S_{MS} = F_a*S_s$	1.781
	$S_{M1} = F_v*S_1$	0.769
	$S_{DS} = 2/3*S_{MS}$	1.187
	$S_{D1} = 2/3*S_{M1}$	0.513
	PGA_M	0.767
MP 2.61	Site Classification	C
	Mapped Spectral Acc. 0.2 Sec. (g)	S_S= 1.476
	Mapped Spectral Acc. 1 Sec. (g)	S_1 = 0.518
	$S_{MS} = F_a*S_s$	1.771
	$S_{M1} = F_v*S_1$	0.767
	$S_{DS} = 2/3*S_{MS}$	1.181
	$S_{D1} = 2/3*S_{M1}$	0.512
	PGA_M	0.761
MP 2.96	Site Classification	C
	Mapped Spectral Acc. 0.2 Sec. (g)	S_S= 1.471
	Mapped Spectral Acc. 1 Sec. (g)	S_1 = 0.516
	$S_{MS} = F_a*S_s$	1.765
	$S_{M1} = F_v*S_1$	0.766
	$S_{DS} = 2/3*S_{MS}$	1.177
	$S_{D1} = 2/3*S_{M1}$	0.511
	PGA_M	0.758

3.3 Peak Ground Accelerations

We performed a probabilistic seismic hazard analysis for each site using the USGS Unified Hazard Tool. Taking into account the regional faults described above, the 2022 California Building Code (CBC), the ASCE 7-16 code coefficient presented in Section 3.2, the results of the peak ground acceleration, and a return period of 475 years (i.e., 10% probability of being exceeded in 50 years), it is our opinion that the proposed improvements could experience peak horizontal ground accelerations as presented in Table 2 below. The computed uniform hazard response spectra each site are presented graphically in Appendix C.

Table 2. Peak Ground Acceleration Based on USGS Unified Hazard Tool

Site	PGA
MP 0.93	0.3714
MP 1.94	0.3751
MP 2.64	0.3745
MP 2.96	0.3778

4.0 SEISMIC GEOHAZARDS

In the following sections, we discuss potential seismic geohazards that may impact the subject site along with the corresponding degrees of estimated potential risk.

4.1 Faulting and Ground Rupture Potential

None of the four (4) project sites are located within a designated Alquist-Priolo Earthquake Hazard Zone (CGS, 1998). Active or potentially active faults are not known to exist on or trend toward the site. As such, the potential for primary ground surface rupture due to faulting is considered to be **low**.

4.2 Tsunami and Seiche Hazard

Based on the general site elevations (about 300 to 1000 feet) and distance to the Pacific Ocean, potential impacts from tsunami hazard are nil. In addition, there are not any nearby large bodies of landlocked surface water nearby and it is unlikely that any earthquake-induced seiche will impact the project site.

4.3 Liquefaction Potential and Related Settlement

Liquefaction occurs when saturated, loose to medium dense, sands and low-plasticity silts and clays are subjected to seismically-induced strong shaking. Liquefiable soils typically lose a portion or all of their shear strength and regain strength sometime after the shaking stops. Soil movements, both vertical and lateral, can occur as a result of liquefaction and ground shaking.

The project locations (4) are not located within a mapped Liquefaction Hazard Zone (aka, Zone of Required Investigation) by the State of California under the Seismic Hazards Mapping Act of 1990. In addition, groundwater is assumed to be much greater 50 feet deep and the bedrock is composed primarily of plastic fine-grained materials. As such, the potential for liquefaction is considered to be very low within the project limits.

4.4 Landslide and Slope Instability

The four (4) project sites are located within a Mapped Landslide Hazard Zone by the State of California (CGS 2002). Further, as previously discussed above, our investigation has identified that northern portions of the project/mapping limits at MP 0.93 and 2.61 are underlain by ancient landslide-affected materials and the entirety of the MP 1.94 project limits is within a relatively massive landslide complex, as mapped by the State of California (2002).

The Yerba Buena Road alignment is a relatively narrow, two-land roadway created via cut/fill grading along steep slopes above Yerba Buena Creek. In addition to the four (4) project sites, we observed many additional areas of distressed pavement and/or downslope embankment erosion/slippage/slope failure between the various project locations.

The potential exists for rock falls, surficial failures and similar slope instability to affect the existing cut slopes on the eastern and/or southern sides of Yerba Buena Road at all four (4) project sites. This potential is particularly acute at the following locations: (1) the northern map/project limits at MP 0.93, where colluvium and/or landslide-affected materials have been mapped and signs of very recent slope instability were observed; (2) the landslide-affected materials exposed and mapped all along the entire length of the MP 1.94 map/project limits ; (3) the northern map/project limits at MP 2.61, where landslide-affected materials have been mapped; (4) anywhere where slope instability has removed vegetation and surficial materials (soil, slopewash, colluvium, etc.) are exposed.

The potential exists for continuing erosion, surficial material (soil, slopewash colluvium, landslide debris) settlement and/or creep, surficial failures and similar slope instability to affect the relatively steep slopes below the future slope (roadway) stabilization at all four (4) project sites.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations for site grading and slope repair alternatives, as presented below, are based on our subsurface exploration, limited laboratory testing, and our experience with similar projects. Recommendations presented below should be incorporated into the project plans and specifications and should be adhered to during construction. Prior to contract bidding, construction plans should be reviewed by Cotton, Shires & Associates for consistency with our recommendations.

5.1 Alternative Repair Options

5.1.1 Do Nothing Option – The County has requested an evaluation of alternative repair options, including a do-nothing option. If the pavement and subgrade soils at the sites are not supported, then they will eventually fail and move downslope, and the roadway limits may be compromised or impinged for through traffic. Soil failure could occur at any time, but will most likely fail because of saturation from rainfall, traffic vibrations, or an earthquake. At a minimum, the County should continue sealing the cracks in the visibly distressed areas, which will help decrease infiltration into the subgrade soils. However, even with a proactive crack sealing program water will still be able to infiltrate the subgrade materials, and the distressed areas will continue to creep downslope/fail at some point in the future.

5.1.2 Soil Nail Walls – Another repair option would be to stabilize the adjacent slopes with soil-nail retaining wall systems. A soil-nail wall would consist of metal bars generally about one-inch in diameter grouted into four- to six-inch diameter (approximate) drill holes placed on a grid pattern on the slope below the roadway. The spacing of the grid-pattern is evaluated as part of a soil-nail slope support design based on the engineering parameters for the soil and rock materials, and other loading (traffic, seismic, etc.). Once the soil-nails are installed and grouted, a reinforced-concrete cover would be placed over the slope to help keep the loose, soft soil materials from moving downslope between the soil-nails.

Due to the relatively steep slopes, shallow soil conditions, and bedding at each site, soil-nail walls would be relatively challenging to construct and likely more expensive than the H-pile walls described below. In addition, the loose surficial fills at each site will continue to settle and cause cracking and distress to the pavement. Loose fill would need to be removed and replaced as compacted fill as part of the project improvements, even with the installation of soil nail walls.

5.1.3 H-Pile Wall – Several segments of Yerba Buena Road have already been repaired or improved with H-pile walls that appear to be performing well, including the 2020/21 repair completed by the County at MP 0.55, which was to mitigate distress conditions similar to those observed at the four sites in this study. Based on the relatively shallow soil depth to be retained at each site, as well as the relatively shallow bedrock or landslide materials available for support, the H-pile repair option appears to be the preferred option at each site from a geotechnical perspective. Similar to the soil nail wall option discussed above, remedial grading and re-paving within the distressed areas will be required in order to remove the upper loose materials and improve drainage. This remedial grading should be conducted after the H-pile walls have been installed.

5.1.4 Repair of Upslope Areas – The County has requested a discussion of upslope areas observed during our distress evaluations that warrant what we consider immediate closer evaluation. As stated above, the potential exists for rock falls, surficial failures and similar slope instability to affect the existing cut slopes on the eastern and/or southern sides of Yerba Buena Road at all four (4) project sites.

Within the limits of our study, there are two (2) locations where, for the reasons listed below, we are recommending immediate closer evaluation. At location #1, the northern map/project limits at MP 0.93 (Figure 4a), tension cracks and signs of recent slope failure(s) were observed within colluvium and landslide-affected materials exposed in the relatively steep cut slope. Future failure(s) have the potential to impact the northbound travel lane. At location #2, the southern map/project limits at MP 2.96 (Figure 7a), recent (2023) slumping and/or surficial failure(s) have occurred in colluvial materials on the ascending slope.

Possible repair alternatives at these locations may include Tecco® mesh with soil nails, or slope lay-back to reduce over-steepened conditions, or impact walls between the slope and roadway, along with drainage improvements which may include concrete brow or v-ditches to direct overland surface flow away from the areas of potential failure. Any option regarding upslope repairs would need to consider limitations imposed by property (right-of-way) limits.

These areas require more in-depth mapping, exploration and evaluation than what was conducted for this pavement distress study. If the County requests further evaluation of repair alternatives, then we can prepare a separate scope for that work.

5.2 Site Development and Grading

5.2.1 Site Preparation – Prior to commencing grading operations, soil materials containing debris, organics, pavement, or other unsuitable materials should be stripped from the structure areas. Demolition of on-grade improvements should include removal of pavements, slabs, abandoned utilities, and soils disturbed during the demolition process. All existing artificial fill located within the footprint of the proposed improvements (as determined by a CSA representative in the field).

Depressions or disturbed areas left from the removal of such material should be replaced with compacted fill.

5.2.2 Excavation Considerations – The earth materials underlying the site should be generally excavatable with heavy-duty earthwork equipment in good working condition. We note the excavation for the planned repair alignment has the potential for difficult excavation conditions (caving and hard drilling zones) in the bedrock materials. Also, we recommend existing utilities be removed from the grading areas and relocated as necessary. A small amount of oversize materials consisting of very hard concretionary siltstone may be generated during site excavations. These materials may not reduce below boulder size through normal cutting and filling operations.

5.2.3 Temporary Excavations – Excavations up to a maximum of about 8 feet in height are anticipated for construction of the preferred slope repair alternative. Excavations are expected to expose artificial fill, natural soil/colluvium (locally), landslide deposits (locally) and moderately hard, fractured and weathered bedrock material consisting of siltstone, shale, semi-siliceous siltstone and fine-grained sandstone. Material should be suitable for vertical excavations up to 5 feet in height where not surcharged by adjacent traffic or structures. Non surcharged temporary excavations greater than 5 feet should be trimmed and laid back at a maximum gradient of 1/2:1 (horizontal to vertical), for the full height of the excavation.

Where sloped embankments are utilized, the tops of the slopes should be barricaded to prevent vehicles and storage loads within a horizontal distance equal to the depth of the excavation. If temporary construction embankments are to be maintained during the rainy season, berms are suggested along the top of slopes where necessary to prevent runoff water from entering the excavation and eroding slope faces. Water should not be allowed to pond on top of the excavation nor flow toward it.

Temporary slopes and excavations should conform to Federal Occupational Safety and Health Administration (OSHA) and/or California Division of Occupational Safety and Health (DOSH) regulations and other applicable local ordinances and building codes, as required. However, the contractor should be made responsible for all safety issues regarding open excavations.

5.2.4 Subgrade Preparation – The finished subgrade surface exposed after over-excavation should be scarified to a depth of 12 inches, moisture-conditioned or dried back to within 0 to 2 percent of optimum moisture and compacted to a relative compaction of at least 90 percent (i.e., 90 percent of the maximum dry density determined from ASTM D1557). Bedrock areas do not need to be over-excavated or scarified.

5.2.5 Fill Material Selection – Recommended fill material selection requirements for subgrade fill, aggregate base, and use of onsite materials are presented below. Areas or zones where the various fill materials may be used are described below.

5.2.5.1 Subgrade Fill – General fill should be free of organics, oversize rock (greater than 3 inches in diameter), trash, debris, and other deleterious or unsuitable materials, and should have an expansion index less than 50 and an R-value of 15 or greater.

5.2.5.2 Aggregate and Miscellaneous Base – Aggregate or miscellaneous base material should be placed below the asphalt pavement. Base materials should consist of imported material conforming to Caltrans Standard Specifications for Class 2 Aggregate Base, Section 26-1.02 (Caltrans, 2020) or Section 200-2.5 of the Greenbook (2018) for Processed Miscellaneous Base. The base materials should have a minimum R-value of 78.

5.2.5.3 Use of Onsite Materials – Materials generated during excavation and grading in pavement areas are generally anticipated to consist of a mixture of fine-grained soil materials with gravel-size and larger rock fragments. Material derived from the over-excavation can be used as subgrade as long as those materials satisfy criteria presented above for subgrade fill and if they are moisture conditioned to near the optimum moisture content (0 to + 2 percent of optimum content). Rocks larger than 4 inches in maximum dimension should be removed from onsite soils to be used as compacted fill. Cobble-size clasts exceeding this dimension were observed in the colluvial soils on the site, and some boulder-size clasts are likely to be generated in excavations within the site bedrock materials

5.2.5.4 Imported Fill – Imported subgrade fill materials should comply with recommendations for subgrade fill or as appropriate for its intended use. Imported fill should be reviewed by the geotechnical engineer prior to being transported to the site.

5.2.6 Fill Placement – Fill materials should be spread evenly, with loose lifts no thicker than eight inches, and should be thoroughly blade-mixed during spreading to provide relative uniformity of material within each layer. Soft or yielding materials should be removed and replaced with properly compacted fill material prior to placing the next layer.

5.2.7 Compaction Requirements – Fill material placed up to one-foot below the pavement section or retaining structures should be compacted to a relative compaction of at least 90 percent of the maximum dry density determined from ASTM D1557, latest edition. Subgrade fill materials placed within one-foot of the pavement section should be compacted to a relative compaction of at least 95 percent of the maximum dry density. As-compacted moisture contents for subgrade fill materials should be within 0 to +2 percent of the optimum moisture as determined from ASTM D1557.

5.2.8 Import Fill – Import fill, if required for the project, should be well-graded granular materials with the following characteristics:

- Non-expansive (EI ≤ 20).
- Friction angle ≥ 30 degrees.
- Maximum particle size < 2 inches.
- Percentage passing the No. 4 sieve between 60 and 100.
- Percentage passing the No. 200 sieve between 10 and 30.
- Plasticity Index < 10.

5.2.9 Cut/Fill Slope Design – All new permanent cut slopes should not exceed an inclination of 2:1 (H:V). All permanent fill slopes constructed with onsite excavated earth materials should have a maximum inclination of 2:1 (H:V). Fill materials placed on slopes steeper than 6:1 should have a keyway excavated into competent bedrock or competent native materials at the toe no less than 10 feet wide, 2 feet deep into bedrock or competent native materials at the toe, 3 feet deep into bedrock or competent native materials at the heel. Fill slopes should be continuously benched at least 1 foot into competent bedrock or competent native materials as the fill slope is brought up to grade. The exposed subgrade should be inspected by our representative for firmness prior to placement of any new fill materials.

5.3 H-Pile Wall Design

Based on the results of the subsurface exploration program for this study, and other repairs undertaken by the County for similarly distressed areas along Yerba Bunea Road, we anticipate that H-piles with lagging will be the preferred distress repair option from a geotechnical perspective. The upper artificial fill materials are likely to settle and deform around new H-piles, and cause distress to the existing pavement if left in-place. The repair project should therefore include removal and compaction of the upper artificial fill materials the H-pile system has been installed, in accordance with the recommendations presented in Section 5.1 above. This section provides foundation design parameters for an H-pile wall similar to the wall installed at MP 0.55 in 2020.

5.3.1 Drilled Shaft Foundations – Drilled shaft foundations should have a minimum embedment of 10 feet into intact siltstone bedrock of the Topanga Formation, or at least 12 feet into Landslide Deposits if the depth to Topanga Formation is prohibitive. In addition, the drilled shaft/pile design will need to consider:

- Traffic loading (if the County applies traffic loading to wall design);
- Use of concrete beam lagging to reduce damage associated with fire;
- Compaction of upper artificial fill materials in the zone between the piles and mapped cracks after installation of the piles is complete; and
- Wall drainage or include saturated soil loading in design.

5.3.2 CIDH Piles – Axial capacity values for a steel H-pile placed in a 24-inch diameter drilled hole are summarized below for end bearing, compression, and tension. Pile design assumes a minimum cast-in-drilled hole (CIDH) pile drilled shaft diameter of 24-inches. Additional axial design recommendations are presented in Table 3 below.

Table 3. Summary of CIDH Allowable Axial Design Values

Mile Post	Allowable End Bearing (compression), psf	Allowable Shaft Friction (compression), psf	Allowable Shaft Friction (tension), psf	Minimum Embedment Depth (ft)
MP 0.93	4,000	600	300	10 feet into Topanga Formation
	3,000	500	250	12 feet into Landslide Deposits
MP 1.94	3,000	500	250	12 feet into Landslide Deposits
MP 2.61	4,000	600	300	10 feet into Topanga Formation
	3,000	500	250	12 feet into Landslide Deposits
MP 2.96	3,000	500	250	12 feet into Landslide Deposits

Caissons may derive lateral bearing support (i.e., passive pressure) from that portion of the pile in contact with the allowable bearing material in accordance with the parameters presented in Table 4 below. The values in Table 4 assume descending ground to the north or west (downslope) of the piles, and level ground at the roadway.

Table 4. Summary of CIDH Allowable Lateral Design Values

Mile Post	Allowable Bearing Material	Allowable Lateral Bearing Pressure psf/ft	Maximum Allowable Lateral Bearing Pressure psf/ft
MP 0.93	Topanga Formation	450	3,500
	Landslide Deposits	300	2,500
MP 1.94	Landslide Deposits	300	2,500
MP 2.61	Topanga Formation	450	3,500
	Landslide Deposits	300	2,500
MP 2.96	Landslide Deposits	300	2,500

The depth of allowable bearing material shall be the elevation of firm, in-place bedrock or landslide deposits. This position shall be assumed to lie three vertical feet below the upper contact of this material. Below this depth of approved bearing material, the foundation may receive credit for lateral passive support, frictional resistance and bearing capacity. In addition, the lateral support may begin below a depth that ensures a 10-foot lateral daylight to the descending slope. The depth of the piles may need to be adjusted in the field based on the actual soil conditions encountered in the drill shaft excavations.

For lateral loading, caissons may be considered fully isolated at a spacing of at least three (3) shaft diameters. All caissons shall be designed to resist a down-slope creep-force of 1,000 pounds per foot of depth, for all soil, colluvium and/or uncertified fill materials encountered above the depth of allowable bearing material. Caissons shall be no closer together than two (2) shaft diameters (measured edge-to-edge) for ease of drilling.

If significant water is present within the caisson excavation (not anticipated), then concrete shall be placed in a manor approved by the project design engineer. Additionally, and as a minimum, when significant water is present within the excavation, the concrete mix shall be increased by at least 1,000 psi over the design psi; however, the designer shall specify the specific changes to the design psi and/or the inclusion of special additives into the design mix to mitigate potential dilution and/or segregation of the paste during placement.

5.3.3 CIDH Installation Considerations – As described above and depicted in Appendix A, the subsurface materials consist of surficial artificial fill underlain by colluvium and landslide deposits, and/or fractured siltstone and sandstone bedrock of the Topanga Formation. These materials have the potential to cave in open excavations. Drilling at MP 1.94 was noted to be occasionally very difficult due to encountering hard oversize materials (cobbles and boulders) in the landslide-affected materials. In addition, the landslide deposits and bedrock materials consist of weak to moderately hard, highly fractured, siltstone bedrock that could cave along fractures and near-vertical bedding planes. There is also the potential to encounter layers of hard, well cemented sandstone, chert, and other zones of hard drilling in the Topanga Formation bedrock.

5.3.4 Lagging – The earth materials anticipated within the depth of lagging are expected to vary significantly. It is recommended that the exposed earth materials be observed by a geotechnical professional to verify the cohesive nature of the earth materials. We understand that wood lagging is not preferred because it could burn in a fire. One mitigation could be to install concrete beam lagging to provide fire protection. It is recommended that the lagging be designed for the full design pressure, but may be limited to a maximum of 400 psf.

Given the erosion potential of the relatively steep, downhill embankment slopes across the four (4) project locations, it is recommended that the lagging extend into bedrock and/or competent native materials a minimum of twelve inches (12”) and no less than three (3) feet below finish grade along the outer edge of the retaining wall profile. An exception to this is at MP 2.96 where, due to the proximity of a recently active slump and associated steep head scarp(s), we recommend that the lagging extend into bedrock and/or competent native materials a minimum of twelve inches (12”) and no less than five (5) feet below finish grade along the outer edge of the retaining wall profile.

5.4 Replacement of Existing Asphalt Concrete Pavement

At a minimum, we recommend that existing asphalt concrete pavement sections be replaced with an equal thickness as asphalt concrete, plus 1 inch. Granular base materials should be replaced with an equal thickness of Caltrans Class II base, Crushed Aggregate Base, or Processed Miscellaneous Base in accordance with the Greenbook (2021). The existing pavement sections at the completed boring locations were recorded during our field exploration, and are shown on the respective borings logs.

5.5 General Corrosivity Considerations

A bulk sample of materials obtained from a boring at each site was tested for resistivity, pH sulfates, and chlorides at the proposed depth of the tank. The results are presented in Table 5 below.

Table 5. Summary of Corrosivity Test Results

Site	Boring/Sample Depth	Material Description	Resistivity (ohm)	pH	Sulfates (%)	Chlorides (%)
MP 0.93	B-10 @ 11 feet	Topanga Formation	2,700	6.4	0.008	0.001
MP 1.94	B-2 @ 6 feet	Landslide Deposits	3,100	6.3	0.009	0.001
MP 2.61	B-8 @ 6 feet	Topanga Formation	3,300	6.1	0.006	0.001
MP 2.96	B-5 @ 3.5 feet	Topanga Formation	6,200	6.3	0.008	0.001

The resistivity values presented above suggest that materials in the project area are moderately corrosive to underground steel (Caltrans, 2020). Tests results for sulfates indicate that onsite soils may be classified as S1 per ACI 318 Table 19.3.1.1. On the basis of sulfate concentration, we recommend that Type II cement be used for concrete in contact with earth materials, in accordance with CBC Chapter 19A (2022).

CSA does not practice in the field of corrosion engineering and the test results presented herein are preliminary. Test results should be evaluated by a qualified corrosion engineer to assess how structures and underground utilities should be protected from anticipated subsurface materials.

5.6 Technical Review

This report, and any supplemental recommendations, should be reviewed by the contractor as part of the bid process. Supplemental geotechnical design recommendations should be provided by our firm based on specific design needs developed by the other project design professionals. It is strongly recommended that no construction be commenced nor grading undertaken until the final drawings, specifications, and calculations have been reviewed and approved in writing by a representative of our firm.

5.7 Earthwork Construction Inspection Testing

All excavations should be inspected by a representative of our firm during site grading and pile installation. Grading should also be inspected and tested, as appropriate, to confirm adequate stripping, subgrade preparation, and compaction of engineered fill. Our office should be contacted within a minimum of 48 hours' advance notice of construction activities requiring inspection and/or testing services.

6.0 INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted engineering geology and geotechnical engineering principles and practices. No warranty, express or implied, or merchantability or fitness, is made or intended in connection with our work, by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings.

This report has been prepared for the exclusive use of the Ventura County Public Works Agency and their authorized agents for design considerations for the Yerba Buena Road Distress project in Ventura County, California. This report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are called to the attention of the project architect and/or engineer and incorporated into the design plans, as appropriate.

7.0 REFERENCES

Documents Reviewed

California Building Code (CBC) (2022), International Conference of Building Officials, July 1.

California Department of Transportation (Caltrans, 2020), Corrosion Guidelines, Version 2.1, January.

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_____ 2018c, U.S. Quaternary Fault database website: https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

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Yerkes, R.F. and Campbell, R.H. (compilers), 2005, Preliminary Geologic Map of the Los Angeles 30′ x 60′ Quadrangle, Southern California, Version 1.0, U.S. Geological Survey Open-File Report 2005-1019, scale 1:100,000.

Aerial Photographs Reviewed

University of California Santa Barbara, Map and Imagery Library, December 1935. ***Flight C-3814*** [air photo]. Scale 1:18,000. Frames 43, 44, 45 and 46, UCSB FrameFinder URL: http://mil.library.ucsb.edu/ap_indexes/FrameFinder/, accessed October 2024 and February 2025.

___, October 1945. ***Flight C-9800*** [air photo]. Scale 1:14,400. Frames 15-1549, 6-527, 6-528, and 7-569, UCSB FrameFinder URL: http://mil.library.ucsb.edu/ap_indexes/FrameFinder/, accessed October 2024 and February 2025.

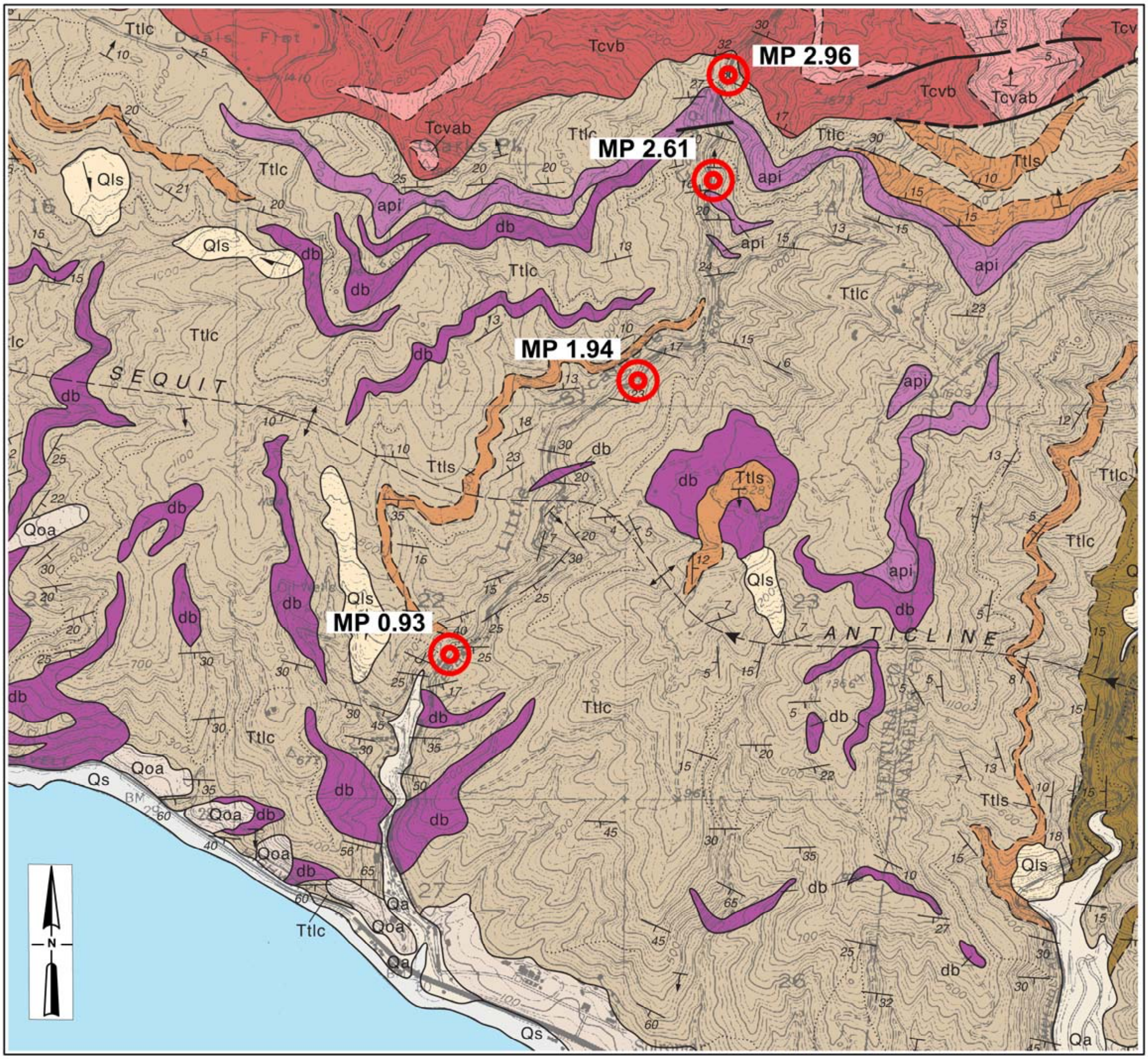
FIGURES

Reference: Modified from the Topographic Map of the Triunfo Pass Quadrangle, prepared by U.S.G.S., 1994.

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

SITE VICINITY MAP
YERBA BUENA ROAD DISTRESS
MILE POSTS (MP) 0.93, 1.94, 2.61 & 2.96
Ventura County, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB/MJJ	1" = 2000'	SC6164
APPROVED BY	DATE	FIGURE NO.
MJJ	APRIL 2025	1



0' 2000' 4000'

Scale 1" = 2000'

EXPLANATION

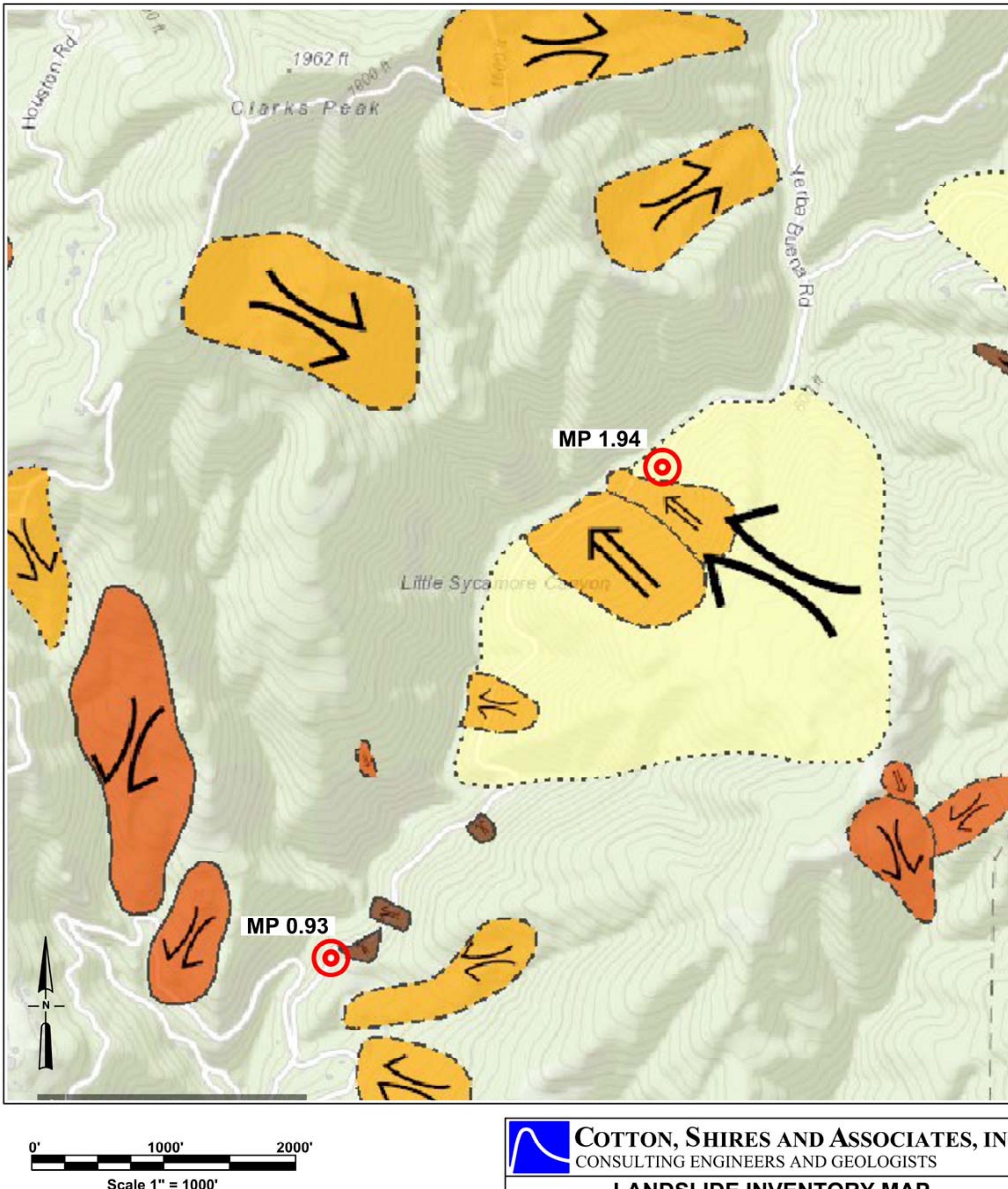
Qs	Beach Sand
Qa	Alluvium
Qls	Landslide Deposits
Qd	Older Alluvium
Tcvb/Tcvab	Conejo Volcanics
db/api	Diabase & Andesite (Intrusives)
Ttlc/Ttls	Topanga Formation

Reference: Dibblee, T.W., 1990, Preliminary Geologic Map of the Point Mugu & Triunfo Pass Quadrangles, Ventura and Los Angeles Counties, California, DF-29.

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

REGIONAL GEOLOGIC MAP
YERBA BUENA ROAD DISTRESS
MILE POSTS (MP) 0.93, 1.94, 2.61 & 2.96
Ventura County, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB/MJJ	AS SHOWN	SC6164
APPROVED BY	DATE	FIGURE NO.
MJJ	APRIL 2025	2



Reference: California Division of Mines and Geology, 2002, Plate 2.1, Seismic Hazard Zone Report for the Triunfo Pass 7.5-Minute Quadrangle, Los Angeles and Ventura Counties, California, Seismic Hazard Zone Report 059.

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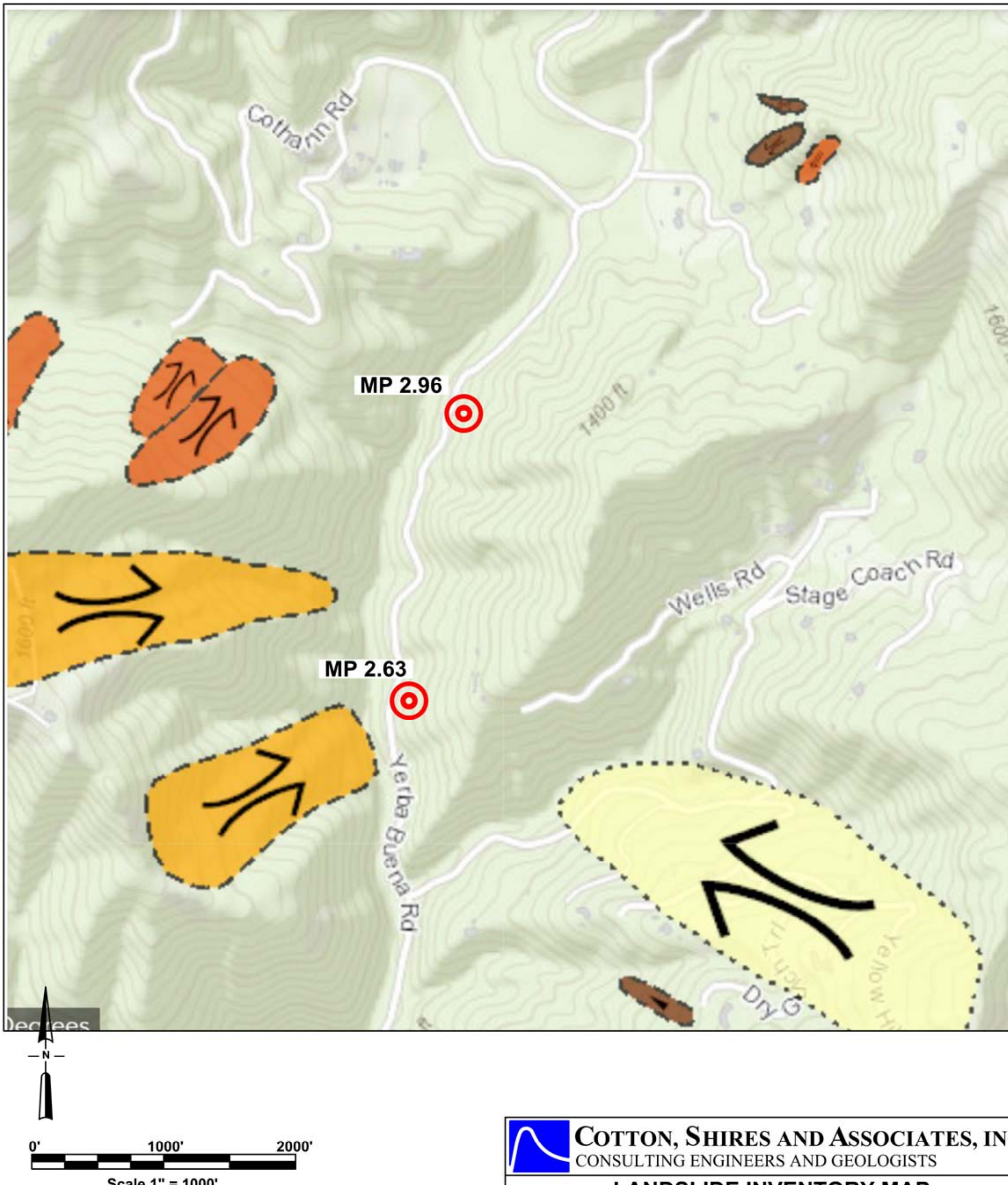
LANDSLIDE INVENTORY MAP
YERBA BUENA ROAD DISTRESS
MILE POSTS (MP) 0.93 & 1.94
Ventura County, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB/MJJ	AS SHOWN	SC6164
APPROVED BY	DATE	FIGURE NO.
MJJ	APRIL 2025	3a

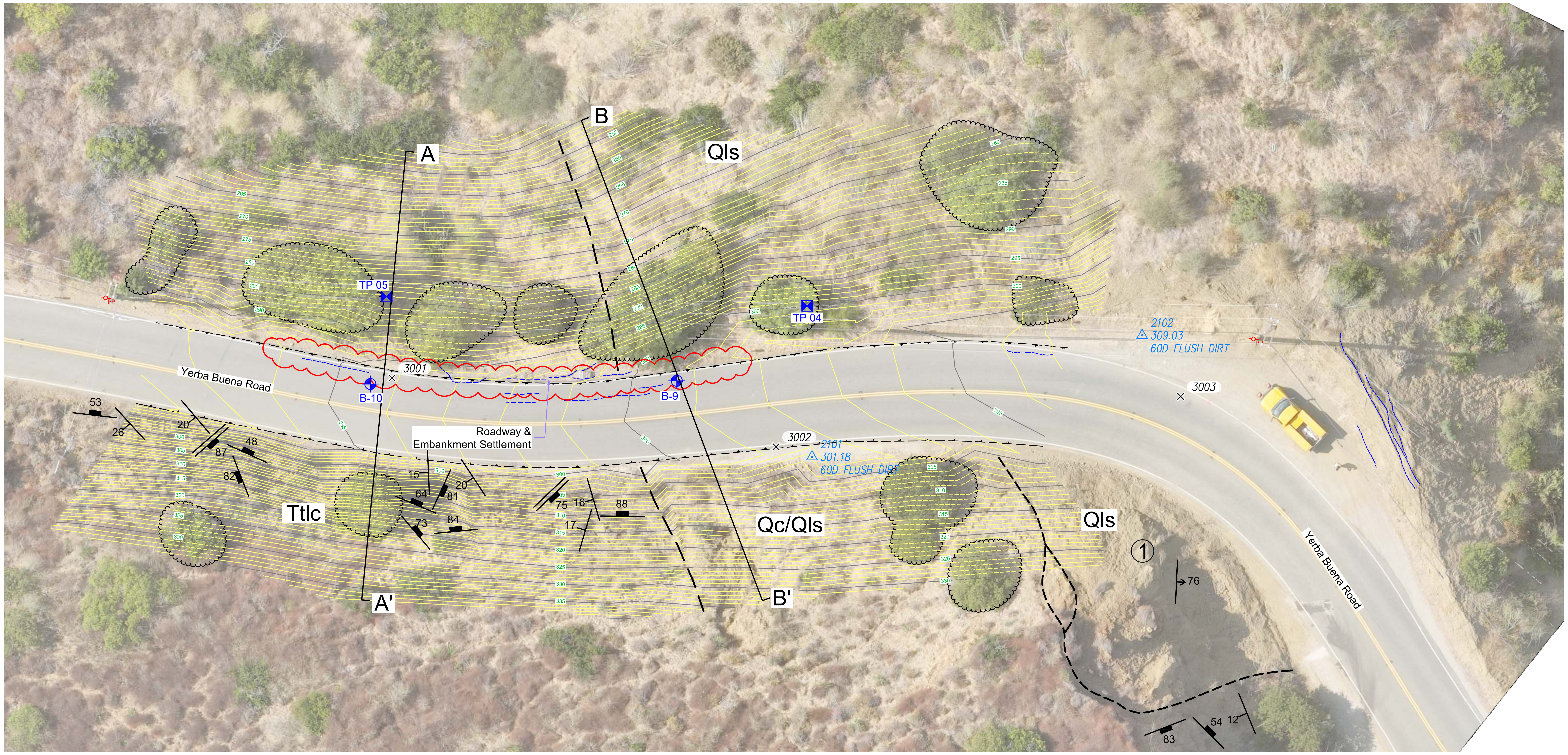


Reference: California Division of Mines and Geology, 2002, Plate 2.1, Seismic Hazard Zone Report for the Triunfo Pass 7.5-Minute Quadrangle, Los Angeles and Ventura Counties, California, Seismic Hazard Zone Report 059.

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

LANDSLIDE INVENTORY MAP
YERBA BUENA ROAD DISTRESS
MILE POSTS (MP) 2.61 & 2.96
Ventura County, CALIFORNIA

GEO/ENG BY EPB/MJJ	SCALE AS SHOWN	PROJECT NO. SC6164
APPROVED BY MJJ	DATE APRIL 2025	FIGURE NO. 3b



LEGEND

af	=	artificial fill
Qc	=	Colluvium
Qal	=	Alluvium
Qsf	=	Surficial failure (recent)
Qs	=	Slump (recent)
Qls	=	Landslide debris and/or landslide-affected bedrock (inactive)
Tcvb	=	Conejo Volcanics (middle Miocene geologic age)
Ttlc	=	Lower Topanga Formation (early to middle Miocene geologic age)
	=	Hollow-stem auger boring
	=	Hand-dug test pit
22	=	Strike and dip of jointing
22	=	Strike and dip of shear
22	=	Strike and dip of bedding
	=	Approximate geologic contact
	=	Geologic cross-section
	=	Pavement cracks
	=	Approximate limits of recommended remedial repair
1	=	Upslope area of Concern (see Report)

North

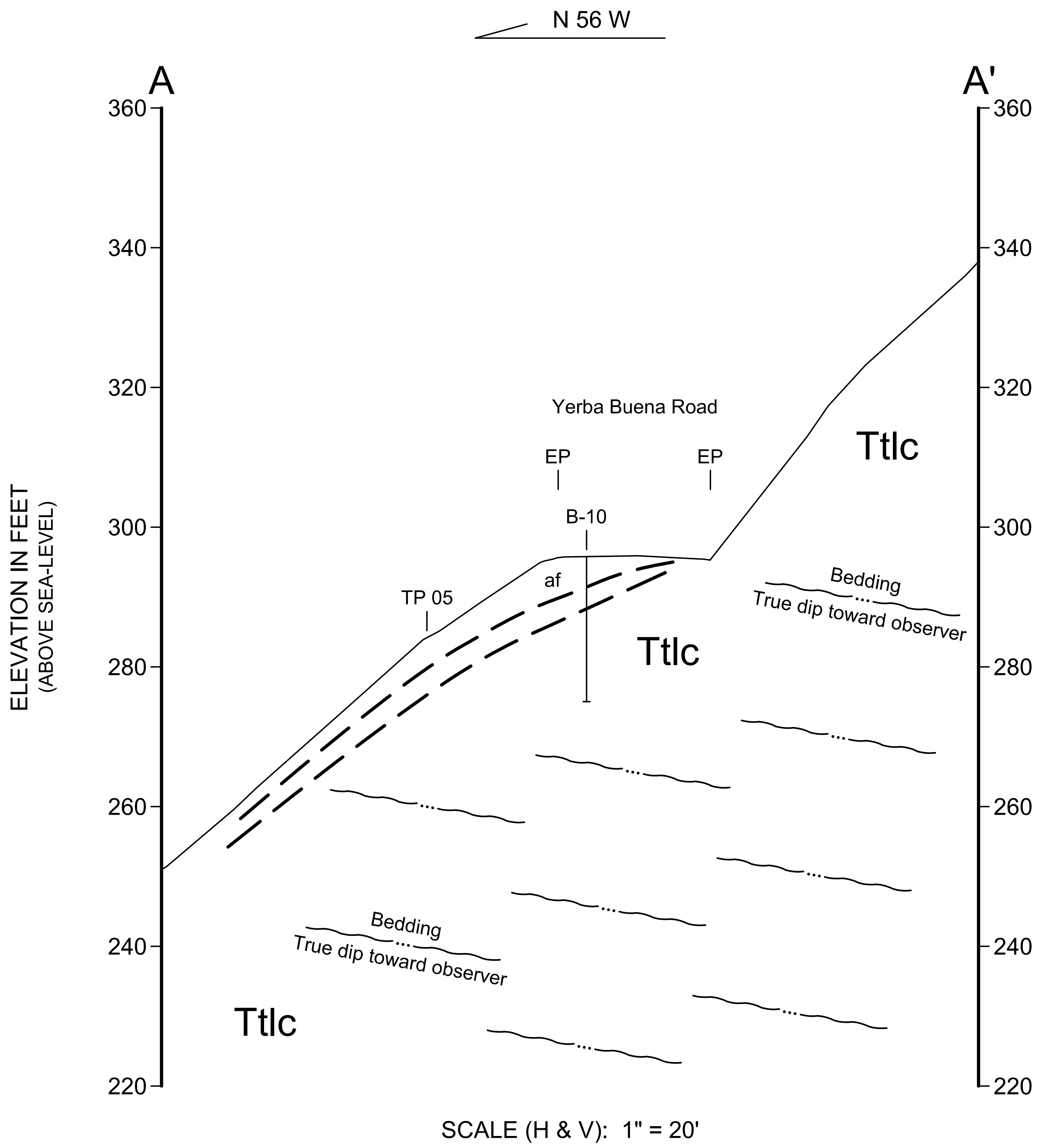
0 10 20 40
(feet)

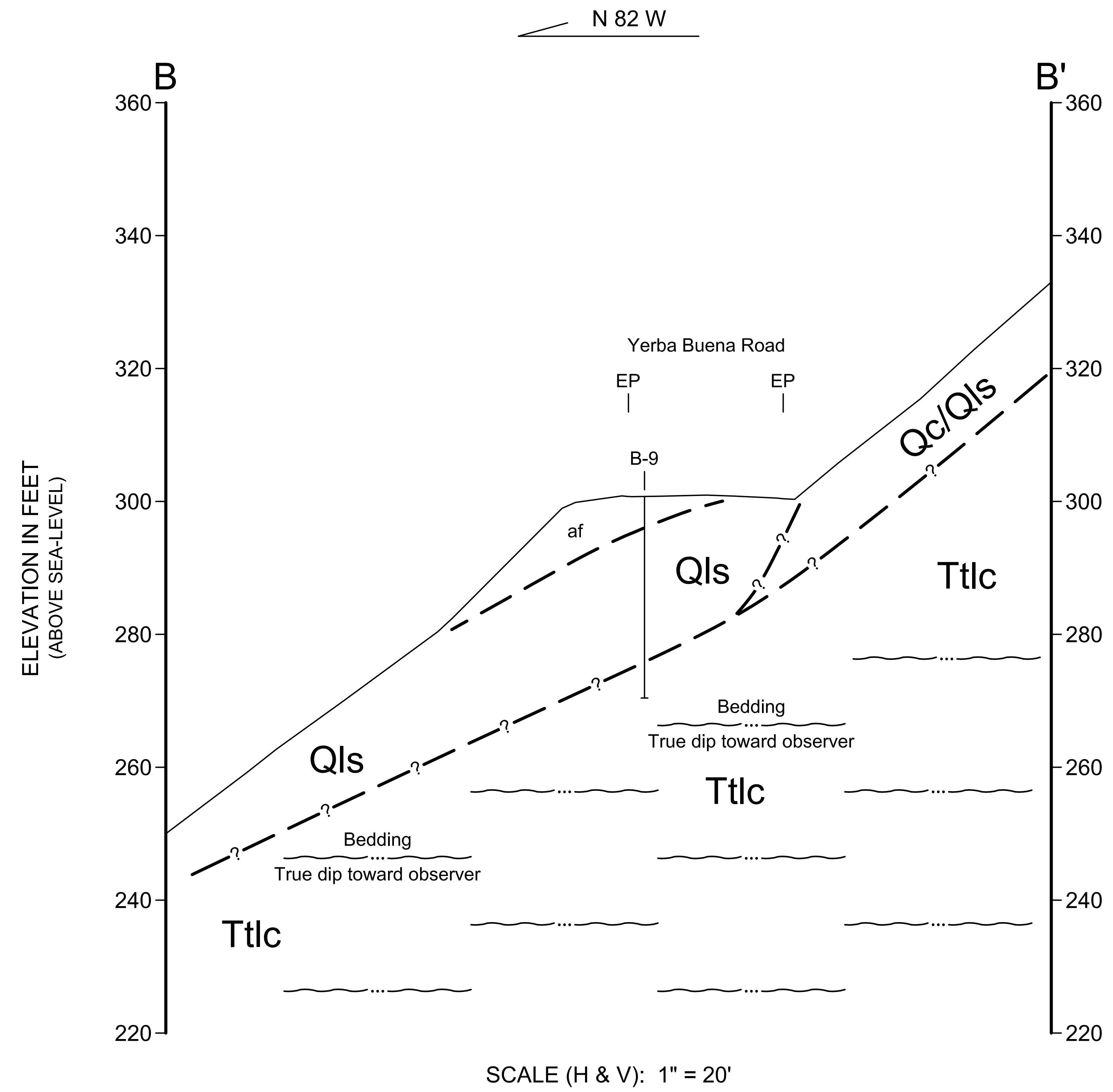
COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

GEOLOGIC MAP
Yerba Buena Road Distress - Mile Post (MP) 0.93
VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=20'	SC6164
APPROVED BY	DATE	FIGURE NO.
EPB/MJJ	April 2025	4a

NOTE: This document has been created from a digital topographic base map prepared by Ventura County, provided January 27, 2025. Analyses and/or professional opinions generated from this plan are only as accurate as the plan(s) provided to this office. If discrepancies are found to exist between the plan(s) and the actual site conditions, they should be brought to our immediate attention so that revisions may be made as required.





COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

GEOLOGIC CROSS-SECTIONS
Yerba Buena Road Distress - Mile Post (MP) 0.93
VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=20'	SC6164
APPROVED BY	DATE	FIGURE NO.
EPB/MJJ	April 2025	4b

LEGEND

af = artificial fill
Qc = Colluvium
Qal = Alluvium
Qsf = Surficial failure (recent)
Qs = Slump (recent)
Qls = Landslide debris and/or landslide-affected bedrock (inactive)
Tcvb = Conejo Volcanics (middle Miocene geologic age)
Ttlc = Lower Topanga Formation (early to middle Miocene geologic age)
= Hollow-stem auger boring
= Hand-dug test pit
22 = Strike and dip of jointing
22 = Strike and dip of shear
22 = Strike and dip of bedding
= Approximate geologic contact
= Geologic cross-section
= Pavement cracks
= Approximate limits of recommended remedial repair

North

0 10 20 40
(feet)

COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

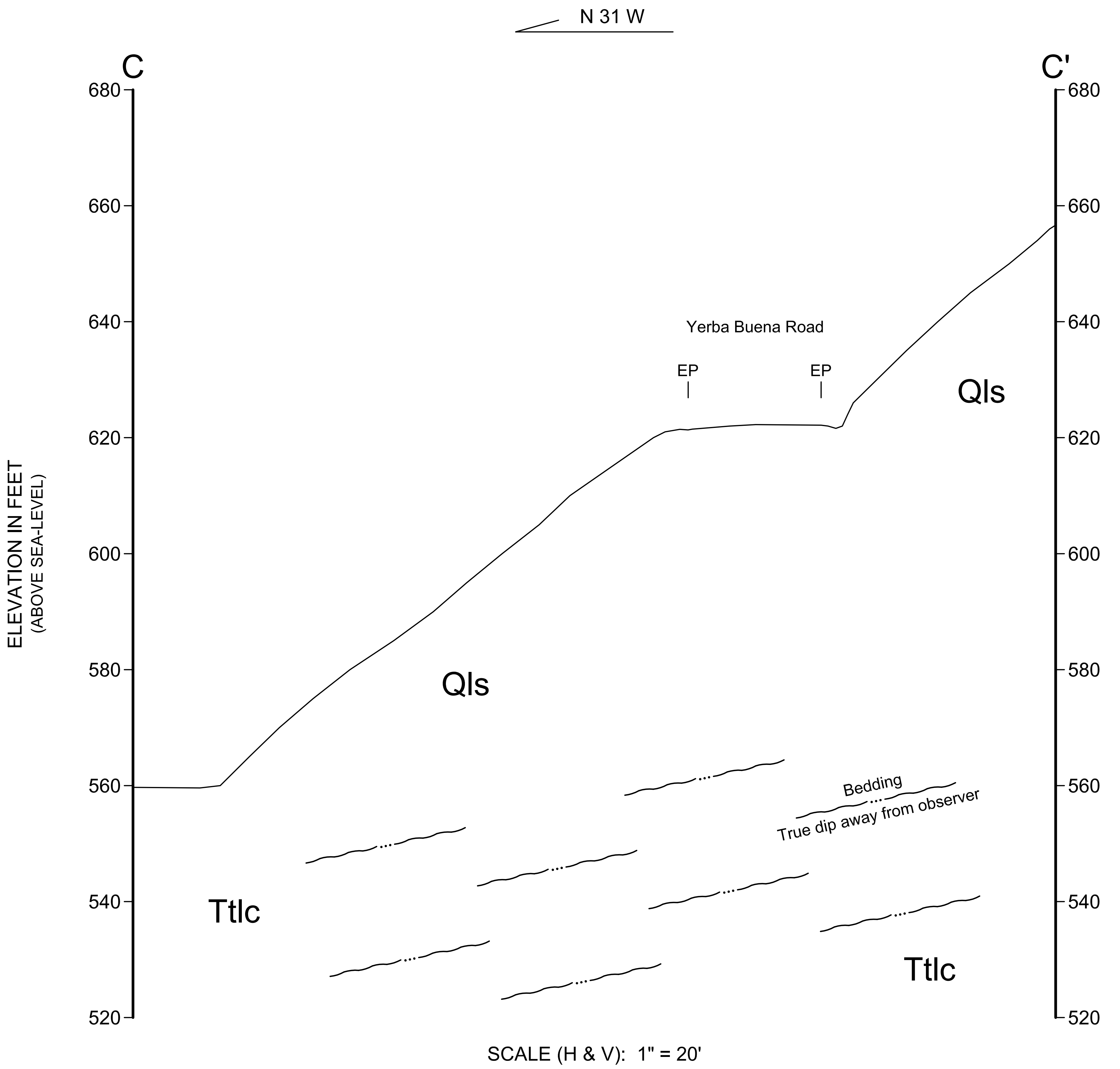
GEOLOGIC MAP

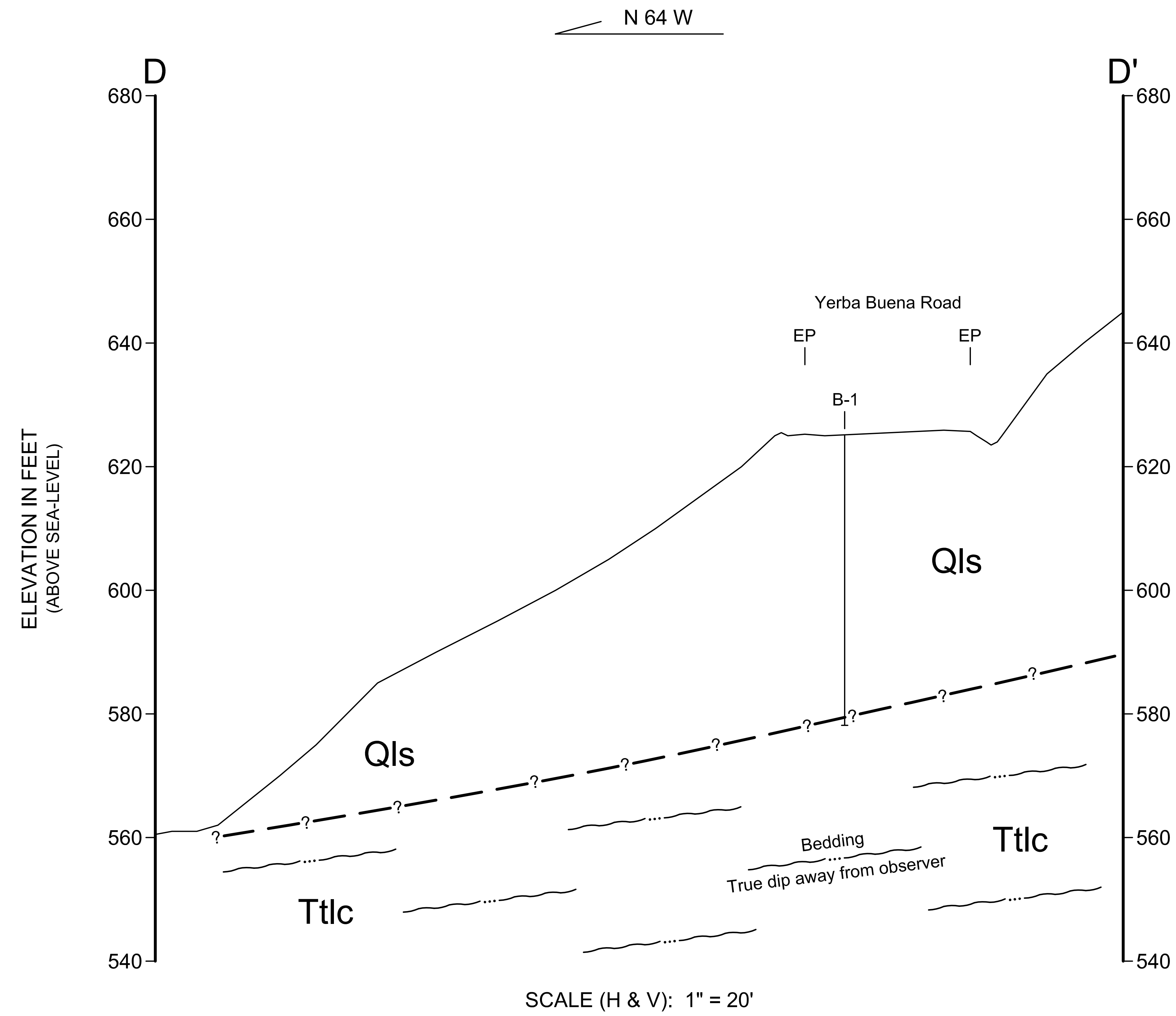
Yerba Buena Road Distress - Mile Post (MP) 1.94

VENTURA COUNTY, CALIFORNIA

GEO/ENG BY EPB	SCALE 1"=20'	PROJECT NO. SC6164
APPROVED BY EPB/MJJ	DATE April 2025	FIGURE NO. 5a

NOTE: This document has been created from a digital topographic base map prepared by Ventura County, provided January 27, 2025. Analyses and/or professional opinions generated from this plan are only as accurate as the plan(s) provided to this office. If discrepancies are found to exist between the plan(s) and the actual site conditions, they should be brought to our immediate attention so that revisions may be made as required.





COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

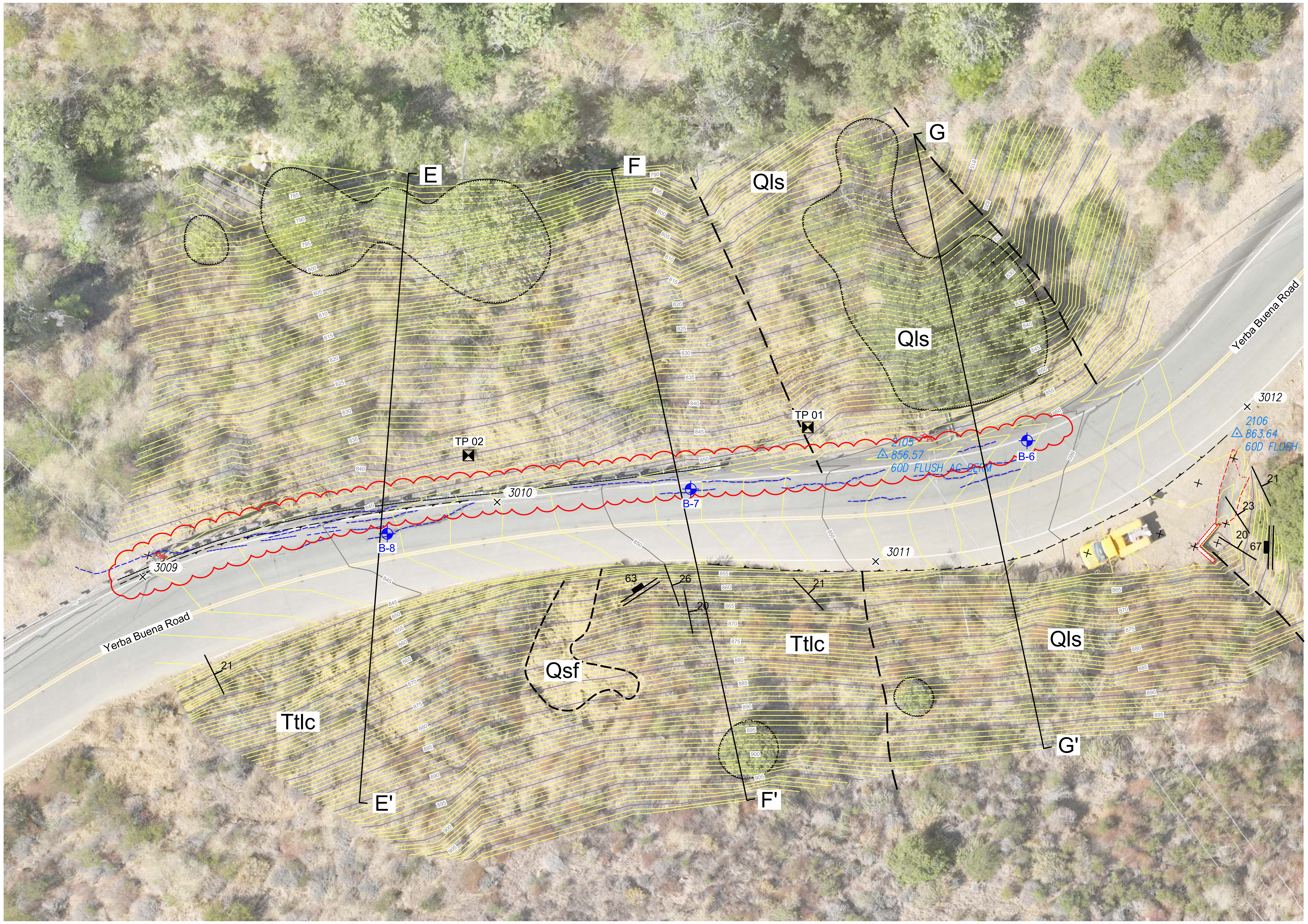
GEOLOGIC CROSS-SECTIONS

Yerba Buena Road Distress - Mile Post (MP) 1.94

VENTURA COUNTY, CALIFORNIA

GEO/ENG BY EPB	SCALE 1"=20'	PROJECT NO. SC6164
APPROVED BY EPB/MJJ	DATE April 2025	FIGURE NO. 5b

NOTE: This document has been created from a digital topographic base map prepared by Ventura County, provided January 27, 2025. Analyses and/or professional opinions generated from this plan are only as accurate as the plan(s) provided to this office. If discrepancies are found to exist between the plan(s) and the actual site conditions, they should be brought to our immediate attention so that revisions may be made as required.



LEGEND

af = artificial fill
Qc = Colluvium
Qal = Alluvium
Qsf = Surficial failure (recent)
Qs = Slump (recent)
Qls = Landslide debris and/or landslide-affected bedrock (inactive)
Tcvb = Conejo Volcanics (middle Miocene geologic age)
Ttlc = Lower Topanga Formation (early to middle Miocene geologic age)
= Hollow-stem auger boring
= Hand-dug test pit
22 = Strike and dip of jointing
22 = Strike and dip of shear
22 = Strike and dip of bedding
= Approximate geologic contact
= Geologic cross-section
= Pavement cracks
= Approximate limits of recommended remedial repair

North

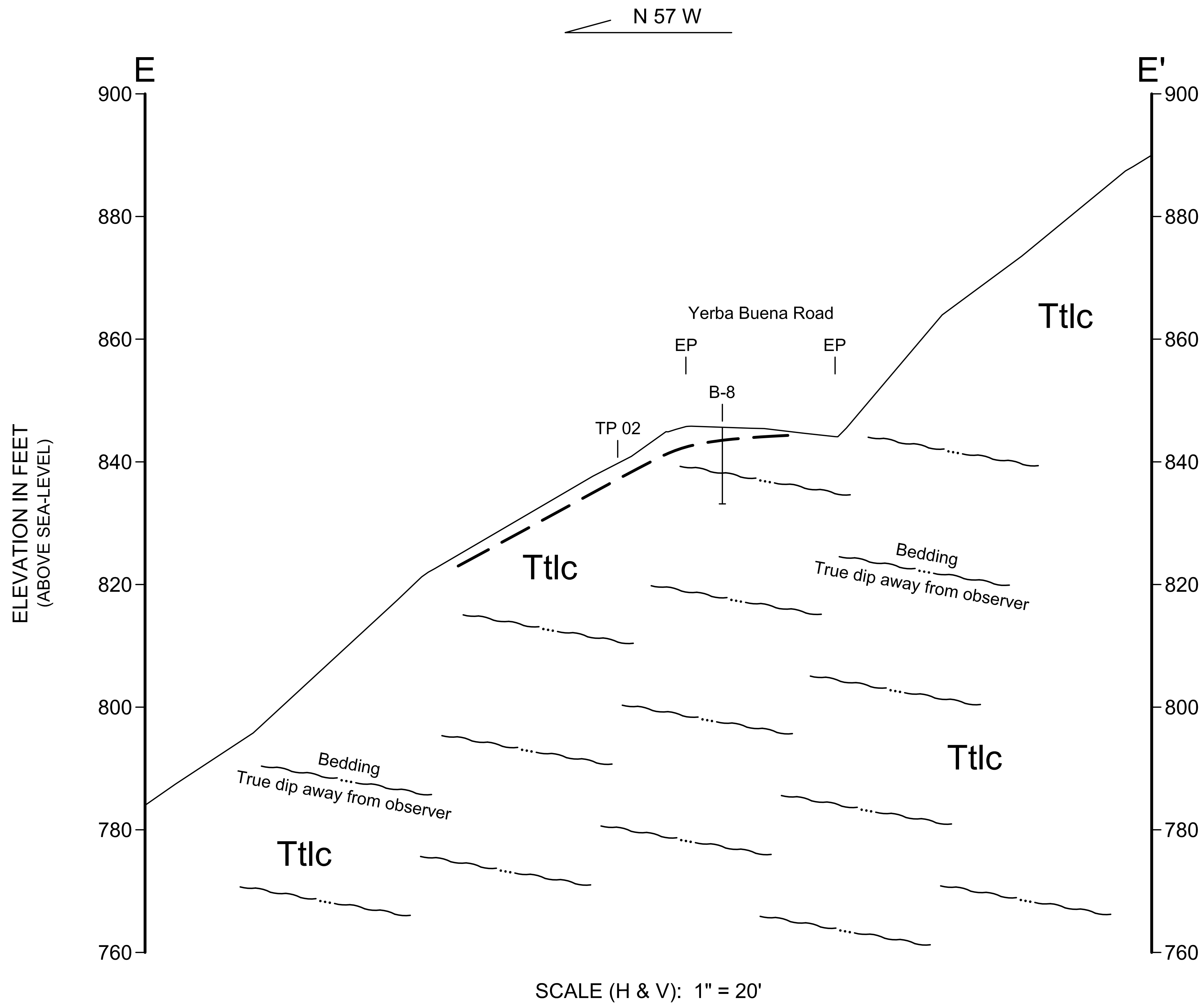
0 10 20 40
(feet)

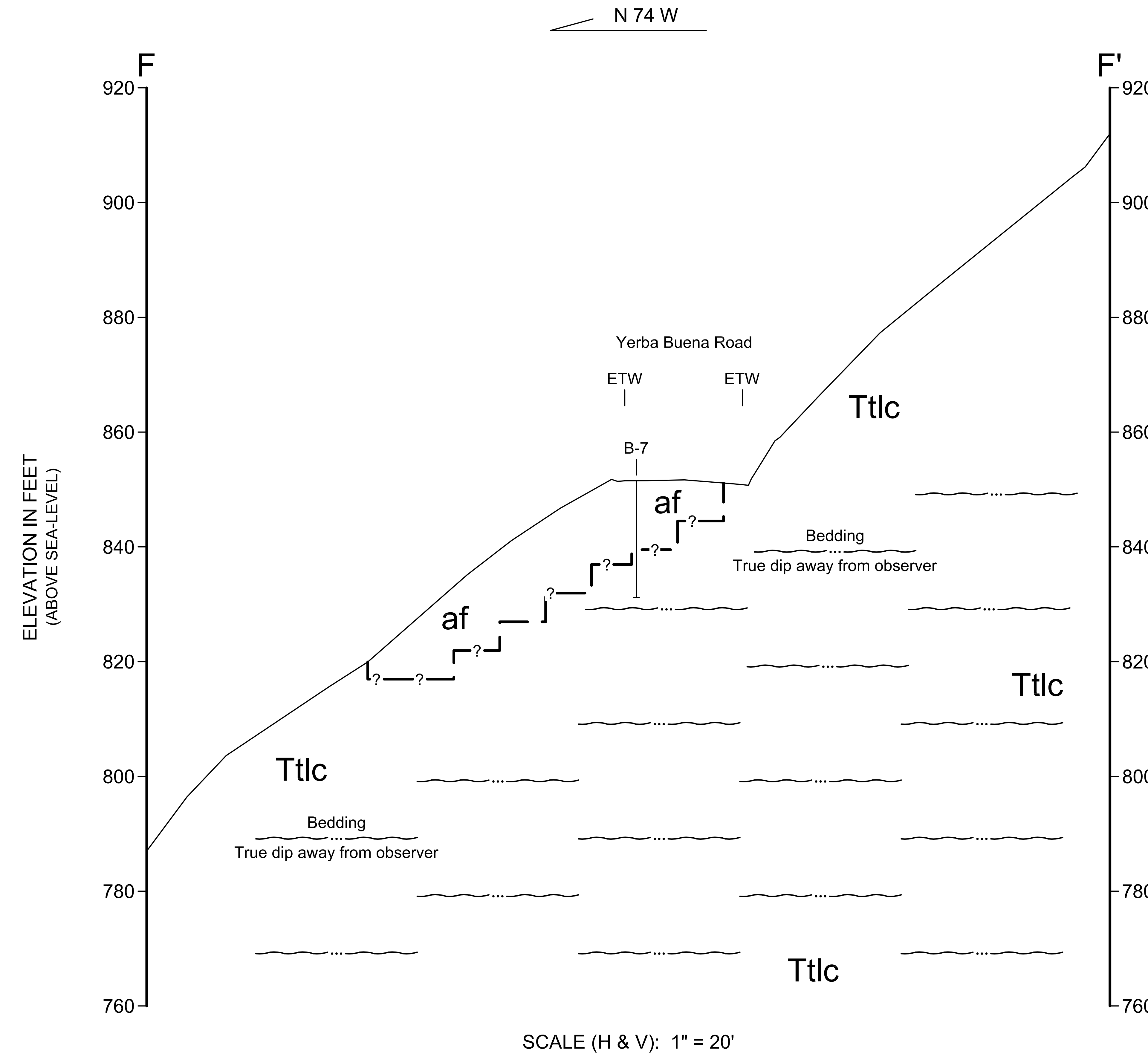
COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

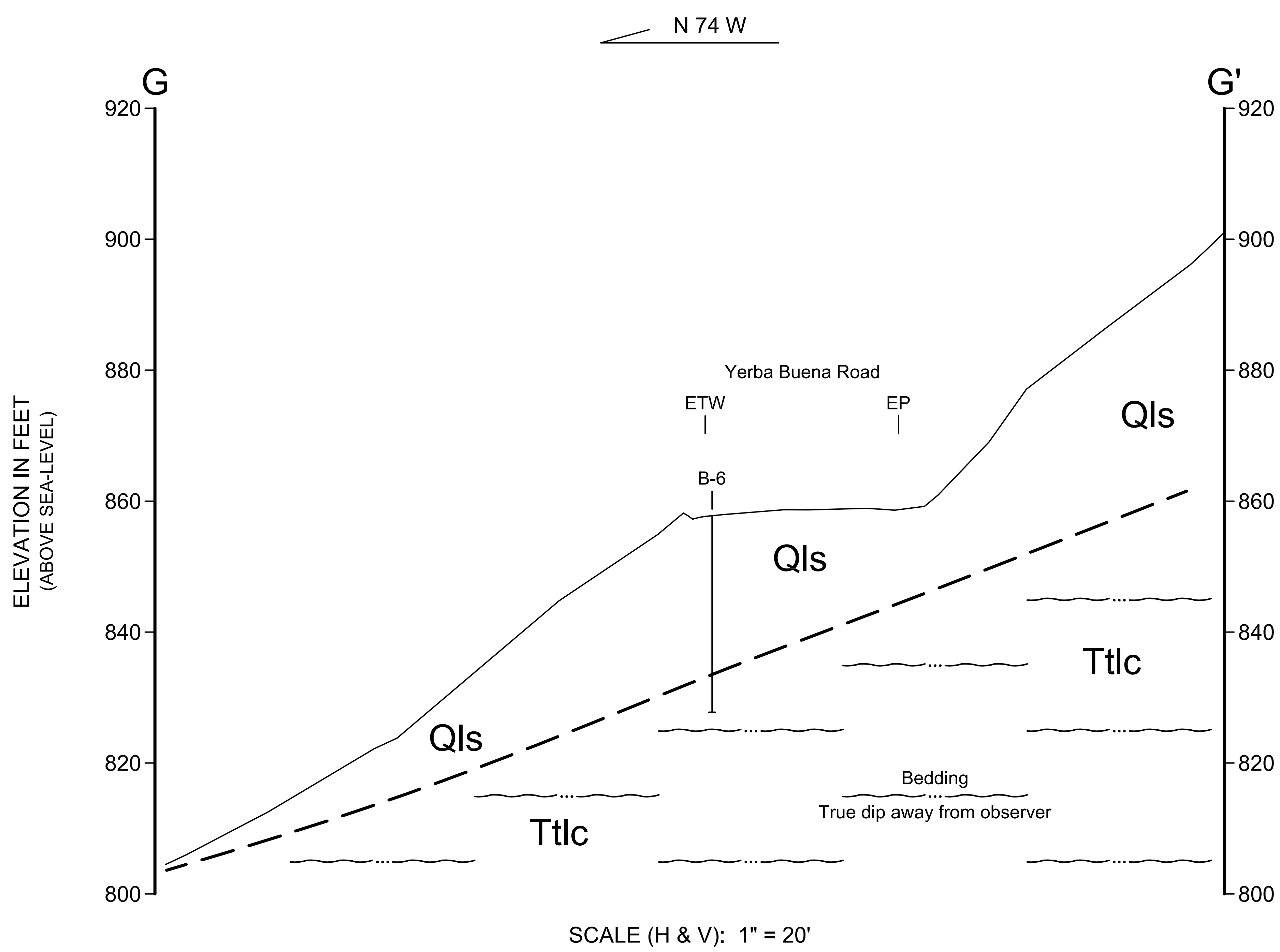
GEOLOGIC MAP
Yerba Buena Road Distress - Mile Post (MP) 2.61
VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=20'	SC6164
APPROVED BY EPB/MJJ	DATE April 2025	FIGURE NO. 6a

NOTE: This document has been created from a digital topographic base map prepared by Ventura County, provided January 27, 2025. Analyses and/or professional opinions generated from this plan are only as accurate as the plan(s) provided to this office. If discrepancies are found to exist between the plan(s) and the actual site conditions, they should be brought to our immediate attention so that revisions may be made as required.







COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

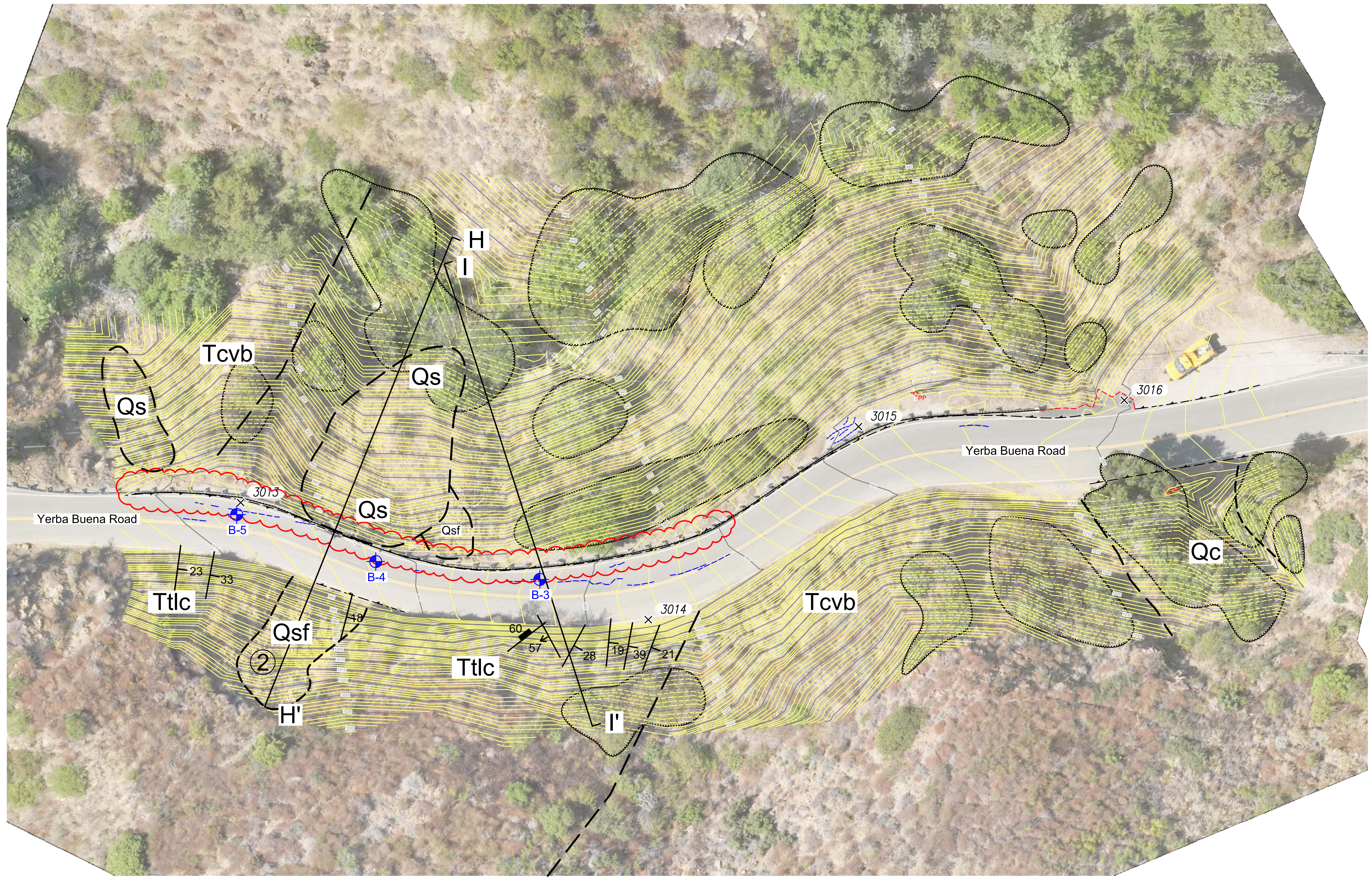
GEOLOGIC CROSS-SECTIONS

Yerba Buena Road Distress - Mile Post (MP) 2.61

WEST MALIBU, VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=20'	SC6164
APPROVED BY	DATE	FIGURE NO.
EPB/MJJ	April 2025	6b

NOTE: This document has been created from a digital topographic base map prepared by Ventura County, provided January 27, 2025. Analyses and/or professional opinions generated from this plan are only as accurate as the plan(s) provided to this office. If discrepancies are found to exist between the plan(s) and the actual site conditions, they should be brought to our immediate attention so that revisions may be made as required.



LEGEND

af	= artificial fill
Qc	= Colluvium
Qal	= Alluvium
Qsf	= Surficial failure (recent)
Qs	= Slump (recent)
Qls	= Landslide debris and/or landslide-affected bedrock (inactive)
Tcvb	= Conejo Volcanics (middle Miocene geologic age)
Ttlc	= Lower Topanga Formation (early to middle Miocene geologic age)
	= Hollow-stem auger boring
	= Hand-dug test pit
22	= Strike and dip of jointing
22	= Strike and dip of shear
22	= Strike and dip of bedding
	= Approximate geologic contact
	= Geologic cross-section
	= Pavement cracks
	= Approximate limits of recommended remedial repair
2	= Upslope area of Concern (see Report)

North

0 15 30 60

(feet)

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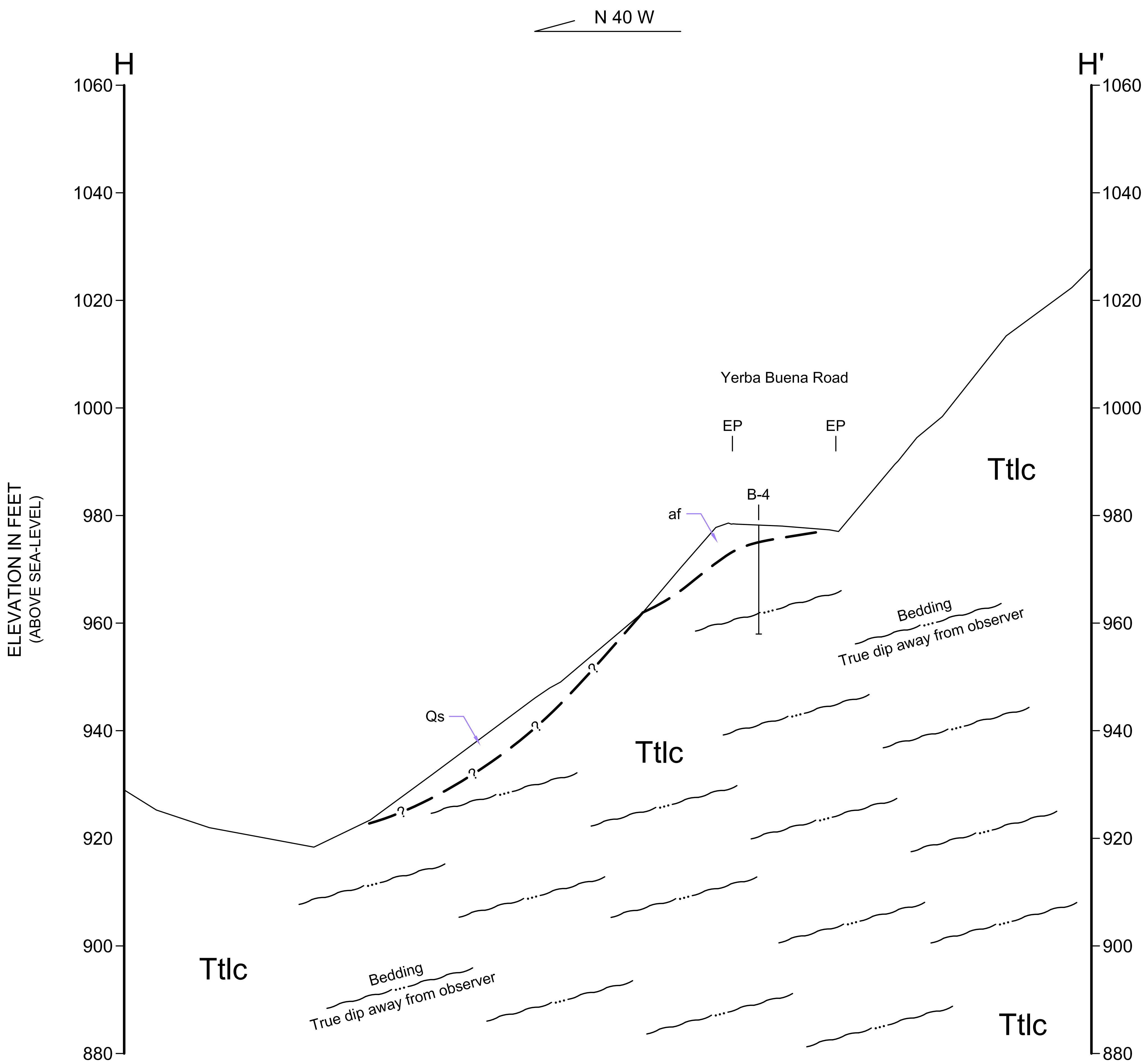
COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

GEOLOGIC MAP

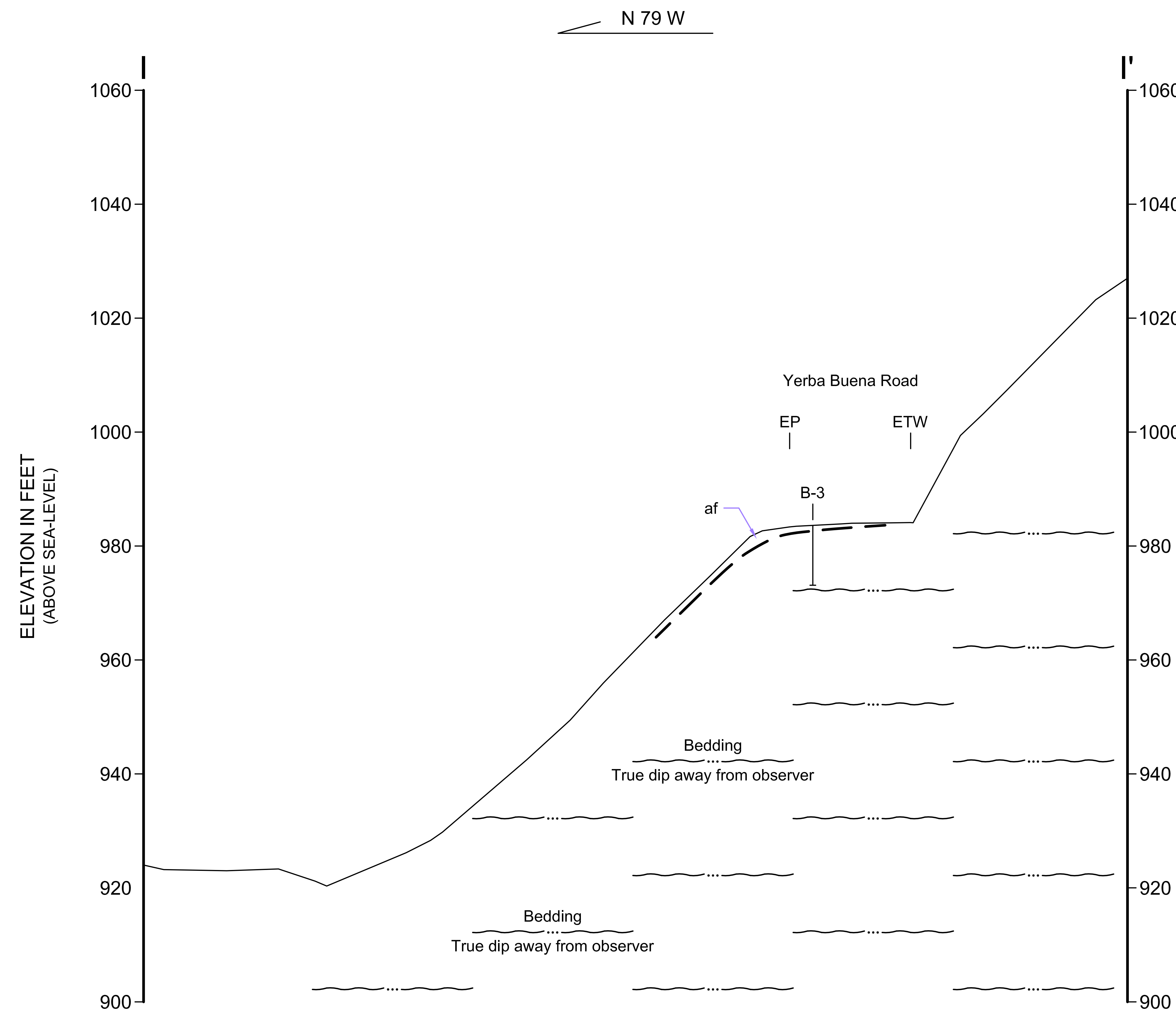
Yerba Buena Road Distress - Mile Post (MP) 2.96

VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=30'	SC6164
APPROVED BY	DATE	FIGURE NO.
EPB/MJJ	April 2025	7a



SCALE (H & V): 1" = 20'



SCALE (H & V): 1" = 20'

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COTTON, SHIRES AND ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

GEOLOGIC CROSS-SECTIONS
Yerba Buena Road Distress - Mile Post (MP) 2.96
VENTURA COUNTY, CALIFORNIA

GEO/ENG BY	SCALE	PROJECT NO.
EPB	1"=20'	SC6164
APPROVED BY	DATE	FIGURE NO.
EPB/MJJ	April 2025	7b

APPENDIX A
FIELD EXPLORATION

APPENDIX A – FIELD EXPLORATION

EXPLORATORY BORINGS

CSA completed multiple subsurface exploration programs between January 6 and 14, 2025, where ten (10) total exploratory borings were conducted within the four (4) project sites. The completed borings ranged in depth from about 9 to 47 feet below ground surface (bgs) and were excavated by means of either truck- or track-mounted drill rigs equipped with 8-inch diameter hollow-stem augers provided by 2R Drilling of Chino, California. The locations of the ten (10) completed borings are shown on Figures 4a to 7a.

Borings were logged by a CSA registered geologist. Subsurface materials were visually classified in accordance with ASTM D-2487 or ASTM D-5434, as applicable. Bulk samples, relatively undisturbed, and disturbed samples were obtained of the materials encountered at selected depths. Relatively undisturbed samples were obtained with a 3-inch diameter modified split-barrel California Sampler and disturbed samples were obtained with a 2-inch diameter split barrel standard penetration sampler. Both samplers were driven by an automatic, 140-lb hammer dropped from a height of 30 inches. The relatively undisturbed samples were typically collected in brass liners that were 2.5 inches in outside diameter and 1 inch tall.

Logs of the borings are presented as Figure Nos. A-1 through A-10. A summary of terms and symbols used in the logs is shown in Figure No. A-0. The logs depict our interpretation of the subsurface conditions at the date and location indicated based on representative samples collected during drilling. It is not warranted that they are representative of subsurface conditions at other times and locations. The contacts on the log represent the approximate boundaries between earth materials, and the transitions between these materials may be gradual.

TEST PITS

Test pits were excavated at five (5) locations across the four (4) project sites. The test pits were excavated between January 20 and 21, 2025, by means of hand equipment provided by Mike's Excavating of Temecula, California. The test pits ranged in depth from about 5 to 6.5 feet bgs. Relatively undisturbed samples were obtained within the test pits through the use of a thin-walled, steel, hand-held sampler. The test pit locations are shown on Figures 4a to 7a.

Logs of the test pits are presented as Figure Nos. A-11 through A-13. The logs depict our interpretation of the subsurface conditions at the date and location indicated based on exposures and representative samples collected during excavation. It is not warranted that they are representative of subsurface conditions at other times and locations. The contacts on the logs represent the approximate boundaries between earth materials, and the transitions between these materials may be gradual.

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-1

Location: MP 1.94 Elevation (ft): 625 Weather: Clear/warm

Drilling Contractor/Rig: 2R Drilling/GT8 Drill Date: 1/6/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	625			9.5" AC; no base							
1	624		SM	**Artificial Fill (Af);** Silty sand with gravel (SM); light gray brown, slightly moist, ifne to medium sand, fine gravel							Bulk 1: 0-5' Moisture: 14.6%
2	623										
3	622			**Colluvium (Qc);** Clayey sand with gravel (SC); medium red brown, moist, loose, fine sand, fine gravel						20 20	
4	621				R1	114.0	6.4	-	MC	15	
5	620		SC							4 4	
6	619				R2	97.0	12.6	-	MC	8	
7	618										
8	617										
9	616			**Landslide Deposits (Qls);** Sandy silt (ML) matrix; light brown, moist, stiff, fine sand, some fine gravel, trace clay							
10	615									13 12	
11	614				R3	118.7	11.5	-	MC	13	
12	613										
13	612		ML								
14	611										
15	610			-- choppy, difficult drilling, at 15 feet (rock fragments, little to no matrix in cuttings)						27 27	
16	609				R4	106.1	6.7	-	MC	19	
17	608										
18	607			Silty sand (SM); light brown to light yellow brown, moist, dense to very dense, with hard sandstone fragments							
19	606										
20	605				R5	109.8	6.6	-	MC	50/4"	
21	604		SM								
22	603										
23	602										
24	601			Gravelly clay (CL); light brown, moist, dense, fine to coarse gravel, clast-supported							
25	600									34 36	
26	599				R6	112.5	11.0	-	MC	38	
27	598		GC								
28	597										
29	596										
30											

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-1

Location: MP 1.94 Elevation (ft): 625 Weather: Clear/warm

Drilling Contractor/Rig: 2R Drilling/GT8 Drill Date: 1/6/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
30	595			GC		R7	-	-	-	MC	33 50/2"	
31	594											
32	593											
33	592				Siltstone/Shale matrix; gray to light gray brown, moist, pervasively fractured, no obervable bedding							
34	591											
35	590					S1	-	-	-	SPT	31 50/5"	
36	589											
37	588											
38	587											
39	586											
40	585					S2	-	-	-	SPT	45 50/3"	
41	584											
42	583											
43	582											
44	581											
45	580				-- very slow drilling, at 45 feet	S3	-	-	-	SPT	50/3"	
46	579											
47	578					S4	-	-	-	SPT	50/1"	
48	577				Auger Refusal at 47'-2" No groundwater encountered. Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.							
49	576											
50	575											
51	574											
52	573											
53	572											
54	571											
55	570											
56	569											
57	568											
58	567											
59	566											
60												

Figure No.: A-1

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-2

Location: MP 1.94 Elevation (ft): 620 Weather: Clear/warm

Drilling Contractor/Rig: 2R Drilling/GT8 Drill Date: 1/6/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	620				7" AC; no base							
1	619			ML	**Artificial Fill (Af);** Sandy silt with gravel (SM); light gray brown, slightly moist, ifne to medium sand, fine gravel							
2	618											
3	617				**Landslide Deposits (Qls);** Sandy silt (ML); light yellowish brown, slightly moist, very stiff, with scattered to abundant siltstone fragments, varies from clast to matrix supported							
4	616											
5	615										9	
6	614				-- difficult drilling, from about 6 to 15 feet	R1	105.3	4.8	14.7	MC	17 23	
7	613											
8	612											
9	611											
10	610				-- continued difficult drilling, at 10 feet						9	
11	609					R2	127.0	6.4	-	MC	19 50/5"	
12	608											
13	607			ML								
14	606											
15	605										5	
16	604				-- buff, cemented sandstone fragments, and light gray to light brown siltstone fragments, closely fractured, caliche-lined, at 16 feet	R3	-	2.8	-	MC	40 50/5"	
17	603											
18	602											
19	601											
20	600										6	
21	599				-- light gray siltstone fragments in silty sand/sandy silt matrix, clast-supported, dense, very difficult drilling, from 21 to 23 feet	R5	128.9	2.1	-	MC	39 48	
22	598											
23	597					S1	-	-	-	SPT	50/3"	
24	596											
25	595											
26	594											
27	593											
28	592											
29	591											
30												

Total Depth 23'-3"
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Figure No.: A-2

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-3

Location: MP 2.96 Elevation (ft): 983 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/GT8 Drill Date: 1/13/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	983				8" AC; no base							
1	982			ML	**Artificial Fill (Af);** Clayey silt (ML); light brown, slightly moist, stiff, with higly fractured shale fragments							
2	981											
3	980			Ttlc	**Lower Topanga Formation (Ttlc);** Sandstone: medium gray brown, moderately weathered, moderately hard, highly fractured, fine grained, interbeded with thinly bedded shale	R1	112.2	2.4	-	MC	22 50/3"	
4	979											
5	978					R2	115.5	4.5	-	MC	50/5"	
6	977											
7	976											
8	975											
9	974											
10	973					S1	-	4.8	-	SPT	50/5.5"	
11	972											
12	971											
13	970											
14	969											
15	968											
16	967											
17	966											
18	965											
19	964											
20	963											
21	962											
22	961											
23	960											
24	959											
25	958											
26	957											
27	956											
28	955											
29	954											
30												

Total Depth 10'-6"
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Figure No.: A-3

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-4

Location: MP 2.96 Elevation (ft): 979 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/13/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	979				8" AC; no base							
1	978			ML	**Artificial Fill (Af);** Clayey silt (ML); light brown, slightly moist, stiff, with higly fractured shale fragments							
2	977											Bulk 1: 0-5' Moisture: 15.1%
3	976			Ttlc	**Lower Topanga Formation (Ttlc);** Shale/Siltstone: medium gray brown, moderately weathered, moderately hard, moderately fractured							
4	975					R1	115.6	8.6	-	MC	6 6 9	
5	974											
6	973					R2	-	-	-	MC	17 22 25	
7	972				-- slwo, difficult drilling, from 7 to 15 feet							
8	971											
9	970											
10	969					R3	-	-	-	MC	50/2"	
11	968											
12	967											
13	966											
14	965											
15	964											
16	963				-- slightly hard, highly oxidized, at 16 feet	S1	-	8.3	-	SPT	7 19 38	
17	962											
18	961											
19	960											
20	959				-- light gray, laminated, slightly to moderately hard, closely fractured	R4	115.7	10.2	-	MC	50/3"	
21	958											
22	957				Total Depth 20'-3" No groundwater encountered. Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.							
23	956											
24	955											
25	954											
26	953											
27	952											
28	951											
29	950											
30												

Figure No.: A-4

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-5

Location: MP 2.96 Elevation (ft): 976 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/13/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	976				9" AC; no base							
1	975			ML	**Artificial Fill (Af);** Clayey silt (ML); light brown, slightly moist, stiff, with higly fractured shale fragments							
2	974											
3	973			Ttlc	**Lower Topanga Formation (Ttlc);** Shale/Siltstone: light gray, moderately weathered, moderately hard, moderately fractured, interbedded fine grained cemented sandstone (very difficult drillling)							
4	972					R1	109.4	3.6	53.5	MC	33 40 42	
5	971					S1	-	3.4	-	SPT	10 50/3"	
6	970											
7	969											
8	968											
9	967											
10	966				Auger Refusal at 9' No groundwater encountered. Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.							
11	965											
12	964											
13	963											
14	962											
15	961											
16	960											
17	959											
18	958											
19	957											
20	956											
21	955											
22	954											
23	953											
24	952											
25	951											
26	950											
27	949											
28	948											
29	947											
30												

Figure No.: A-5

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-6

Location: MP 2.61 Elevation (ft): 859 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/13/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0–1.5	859–857.5		17" AC; no base							
1.5–3.5	857.5–855.5	ML	**Artificial Fill (Af);** Sandy silt (ML); light to medium brown, moist, medium stiff, fine sand, with highly fractured siltstone fragments							
3.5–24	855.5–835	ML	**Colluvium (Qc)/Landslide Deposits (Qls);** Sandy silt (ML); medium brown, slightly moist, stiff, fine sand, with scattered to abundant fine gravel, occasional rootlets							
4	855			R1	122.8	4.4	-	MC	6 6 7	
6	853			R2	120.6	7.6	-	MC	9 10 12	
7	852		-- veru difficult drilling, to about 15 feet							
11	848			R3	-	-	-	MC	8 7 10	
16	843			R4	118.2	11.6	-	MC	15 21 22	
21	838		-- less matrix (occasional pockets), highly fractured siltstone and cemented shale, at 21 feet	R5	117.4	9.6	-	MC	12 18 22	
24–30	835–829	Ttlc	**Lower Topanga Formation (Ttlc);** Shale/Siltstone: light gray, moderately weathered, moderately hard, moderately fractured							
25	834			R6	-	-	-	MC	50/2"	
30	829			S1	-	-	-	SPT	50/1"	

Total Depth 30'
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Figure No.: A-6

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-7

Location: MP 2.61 Elevation (ft): 852 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/13/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0–1.2	852				14" AC; no base							
1.2–12	851–840			CL	**Artificial Fill (Af);** Sandy clay (CL) to Clayey sandy silt (ML) matrix; medium to dark gray brown; moist, medium stiff, fine sand, with waethered siltstone fragments	R1	107.7	15.5	-	MC	3 4 5	
					-- light gray to light brown weather claystone/siltstone fragments (no matrix), at 6 feet	R2	119.1	11.6	-	MC	7 11 12	
					-- increased siltstone fragments, loose, piece of thin gauge wire, at 11 feet	R3	108.7	7.1	-	MC	3 14 11	
12–20.3	840–832			Ttlc	**Lower Topanga Formation (Ttlc);** Shale/Siltstone: light to medium gray, moderately weathered, moderately hard, moderately fractured, thinly bedded, semi-silicious	R4	116.0	4.7	-	MC	50/4"	
						R5	-	-	-	MC	50/4"	

Total Depth 20'-3"
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Depth scale (ft): 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Elevation scale (ft): 852 851 850 849 848 847 846 845 844 843 842 841 840 839 838 837 836 835 834 833 832 831 830 829 828 827 826 825 824 823

Figure No.: A-7

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-8

Location: MP 2.61 Elevation (ft): 846 Weather: Sunny/windy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/14/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	846				9.5" AC; no base							
1	845			SM	**Artificial Fill (Af);** Silty sand (SM); gray brown, slightly moist, medium dense, fine grained, with scattered small siltstone fragments							
2	844											
3	843				**Lower Topanga Formation (Ttlc);** Shale/Siltstone: light gray brown to light brown, moderately weathered, moderately hard, moderately fractured, thinly bedded, oxidized						10 11	
4	842					R1	117.9	7.7	15.7	MC	17	
5	841										7 13	
6	840					R2	-	-	-	MC	46	
7	839			Ttlc	-- difficult drilling, at 7 feet							
8	838											
9	837											
10	836										34	
11	835				-- light gray, decreased fracturing, laminated to thinly bedded, diffcult drilling, transitions to hard cemented sandstone	S1	-	4.8	-	SPT	50	
12	834					S2	-	-	-	SPT	50/1.5"	

Total Depth 12'-1.5"
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Depth scale continues: 13 (833), 14 (832), 15 (831), 16 (830), 17 (829), 18 (828), 19 (827), 20 (826), 21 (825), 22 (824), 23 (823), 24 (822), 25 (821), 26 (820), 27 (819), 28 (818), 29 (817), 30

Figure No.: A-8

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-9

Location: MP 0.93 Elevation (ft): 300 Weather: Sunny/breezy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/14/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0–1	300–299				13" AC; no base							
1–4.5	299–295.5			ML	**Artificial Fill (Af);** Sandy silt (ML); light to medium brown, slightly moist, stiff, with siltstone fragments, clast supported	R1	108.0	7.6	-	MC	10 14 14	Bulk 1: 0-5' Moisture: 3.3%
4.5–6.5	295.5–293.5			ML	**Natural Soil (Qs);** Sandy silt (ML); medium brown, moist, stiff, with siltstone fragments, occasional rootlets	R2	103.2	12.0	-	MC	10 14 12	
6.5–24.5	293.5–275.5			SC	**Colluvium (Qc)/Landslide Deposits (Qls);** Clayey silty sand (SC); light brown, moist, medium dense, with abundant fine gravel, varies from clast to matrix supported, heavily oxidized	R3	-	-	-	MC	25 12 14	
						S1	-	-	-	SPT	10 10 4	
					-- relatively lighter drilling, from about 16.5 to 20 feet							
						R4	-	-	-	MC	13 10 5	
					-- pervasively fractured, highly oxidized and slickensided siltstone fragments, at 23 feet	R5	127.8	7.3	-	MC	13 19 40	
24.5–30	275.5–270			Ttlc	**Lower Topanga Formation (Ttlc);** Shale/Siltstone: light gray, moderately weathered, moderately hard, lightly fractured, thinly bedded, oxidized	R6	118.0	3.6	-	MC	16 43 50/4	

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-9

Location: MP 0.93 Elevation (ft): 300 Weather: Sunny/breezy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/14/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
30	270			Ttlc								
31	269				Total Depth 30'-4" No groundwater encountered. Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.							
32	268											
33	267											
34	266											
35	265											
36	264											
37	263											
38	262											
39	261											
40	260											
41	259											
42	258											
43	257											
44	256											
45	255											
46	254											
47	253											
48	252											
49	251											
50	250											
51	249											
52	248											
53	247											
54	246											
55	245											
56	244											
57	243											
58	242											
59	241											
60												

COTTON, SHIRES AND ASSOCIATES, INC.

LOG OF EXPLORATORY DRILLING

Project: VCPWA - Yerba Buena Road Distress Logged By: EPB Project Number: SC6164 Boring: B-10

Location: MP 0.93 Elevation (ft): 295 Weather: Sunny/breezy

Drilling Contractor/Rig: 2R Drilling/CME 55 Track Drill Date: 1/14/25 Hole Diameter (in): 8

Depth (ft)	Elevation (ft)	Water Level	Graphic Log	USCS	DESCRIPTION	Sample Designation	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Sample Type	Field Blow Count	Remarks
0	295				11.5" AC; no base							
1	294			SM	**Artificial Fill (Af);** Silty sand (SM); light to medium brown, slightly moist, loose, with abundant rock fragments, matrix supported							
2	293											
3	292					R1	108.2	7.6	-	MC	12 50/5"	
4	291											
5	290			ML	**Colluvium (Qc);** Sandy silt (ML); medium brown, moist, stiff, fine sand, trace clay, with abundant small siltstone fragments, matrix supported							
6	289					R2	-	-	-	MC	18 19 14	
7	288											
8	287			Ttlc	**Lower Topanga Formation (Ttlc);** Sandstone; buff, moderately weathered, moderately hard, highly fractured							
9	286											
10	285											
11	284					R3	116.6	3.4	-	MC	18 30 36	
12	283											
13	282											
14	281											
15	280				-- light brown, finre grained, slightly to moderately hard, at 15 feet	S1	-	7.9	-	MC	13 50/5.5"	
16	279											
17	278			Ttlc	Siltstone: medium gray, moderately hard to hard, highly fractured, cemented, laminated to thinly bedded							
18	277											
19	276											
20	275					R5	120.2	5.2	-	MC	37 50/4"	
21	274											
22	273											
23	272											
24	271											
25	270											
26	269											
27	268											
28	267											
29	266											
30												

Toal Depth 20'-9"
No groundwater encountered.
Boring backfilled with cuttings and hydrated cement, capped with quickset concrete dyed black.

Figure No.: A-10

Rig Type: Hand Tools

Test Pit Location: Mile Post 0.93

COTTON, SHIRES AND ASSOCIATES, INC.

EXPLORATORY TEST PIT LOG No. TP-04 & 05

Project No: SC6164

Date Logged: 1/21/25

Logged By: EPB

ENGINEERING GEOLOGIC DESCRIPTION

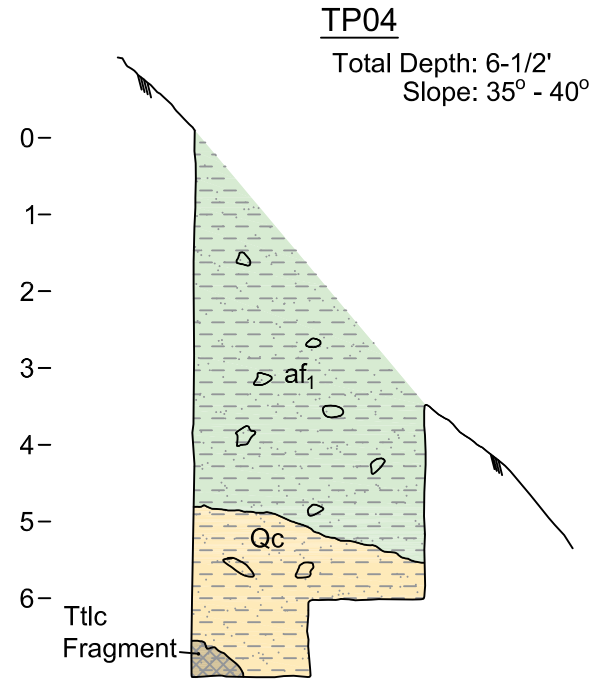
af_1: Silty sand to sandy silt matrix, light brown to tan, mottled, moderately compact to compact, dry to slightly moist, upper 1' was distrubed and loose, abundant bedrock fragments up to 5" across, scattered roots and rootlets

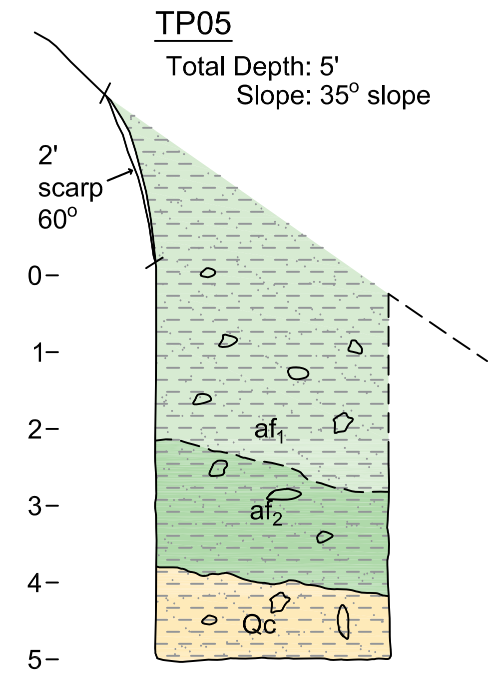
af_2: Sandy silt to silty sand, brown to reddish brown, mottled, slightly moist to moist, abundant bedrock fragments up to 5" across, occasional rootlet

Qc: Sandy silt, brown, medium dense, slightly moist to moist, very fine to medium sand, abundant bedrock fragments up to 5" across, occasional rootlet

GRAPHIC REPRESENTATION

SCALE: 1" = 2.5'





Rig Type: Hand Tools

Test Pit Location: Mile Post 1.94

COTTON, SHIRES AND ASSOCIATES, INC.

EXPLORATORY TEST PIT LOG No. TP-03

Project No: SC6164

Date Logged: 1/20/25

Logged By: EPB

ENGINEERING GEOLOGIC DESCRIPTION

af: Sandy silt to silty sand, light brown to brown, mottled, slightly moist to moist, slightly compact to compact, very fine to medium sand, abundant bedrock clasts up to 6" across, scattered roots and rootlets, scattered construction debris, occasional rodent hole in upper 6"

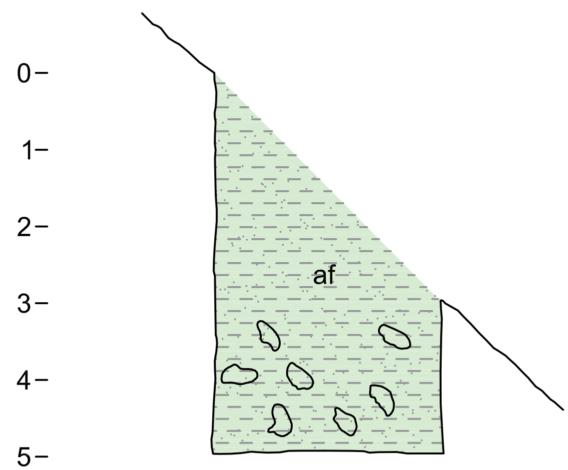
GRAPHIC REPRESENTATION

SCALE: 1" = 2.5'

TP03

Total Depth: 5'

Slope: 45° & steeper



Rig Type: Hand Tools

Test Pit Location: Mile Post 2.61

COTTON, SHIRES AND ASSOCIATES, INC.

EXPLORATORY TEST PIT LOG No. TP-01 & 02

Project No: SC6164

Date Logged: 1/20/25

Logged By: EPB

ENGINEERING GEOLOGIC DESCRIPTION

af_1: Silty sand to sandy silt, light brown to brown, dry to slightly moist, very fine to medium sand, abundant gravel to cobble sized bedrock fragments, loose in the upper 6" increasing to moderately compact below that, occasional root & construction debris up to 18" across

af_2: Silty sand to sandy silt, brown, slightly moist to moist, very fine to medium sand, abundant gravel to cobble sized bedrock fragments, slightly to moderately compact, scattered rootlets, occasional fragment up to 18" across

Qc: Sandy silt, brown to red brown, slightly moist to moist, medium dense, abundant bedrock fragments, possible clay binder

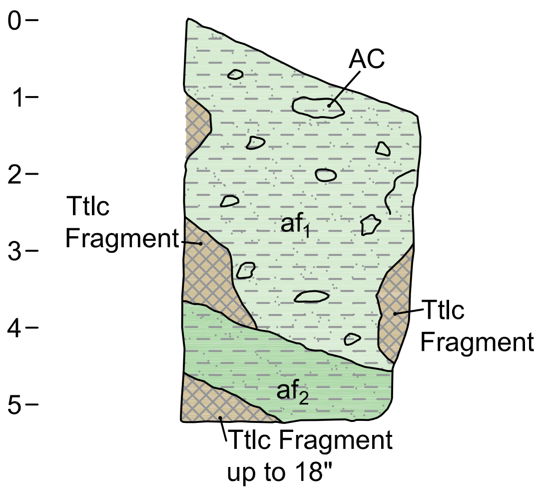
Ttlc: Thinly bedded to laminated medium gray siltstone/shale, moderately hard to hard, highly fractured, some fractures are open and some are filled

GRAPHIC REPRESENTATION

SCALE: 1" = 2.5'

TP01

Total Depth: 5-1/4'
Slope: 36°

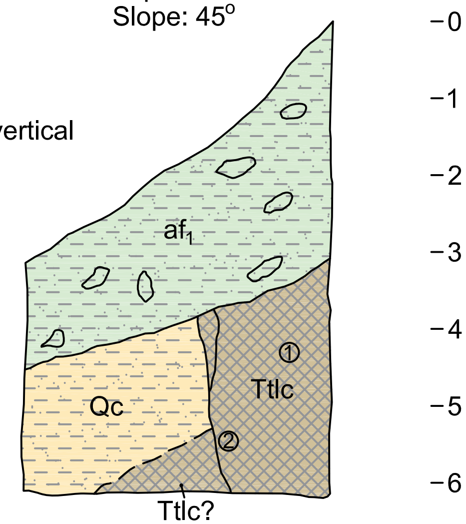


TP02

Total Depth: 6'
Slope: 45°

① Bedding: N84W,22N

② Fissure: N11-12W, near-vertical and slightly irregular



APPENDIX B
LABORATORY TESTING

APPENDIX B –LABORATORY TESTING

INTRODUCTION

Laboratory analyses performed for the project consisted of limited testing of the principal soil types sampled during the field investigation to evaluate index properties of subsurface materials. Laboratory tests were performed on selected driven ring or bulk soil samples to estimate engineering characteristics of the various earth materials encountered. Testing was performed in general accordance with ASTM Standards for Soil Testing, latest revision. Soil descriptions and the field and laboratory test results were used to assign parameters to the various materials at the site. Testing procedures are presented below, and results of the laboratory testing program are presented in this appendix, and the boring logs included in Appendix A.

Laboratory Moisture and Density Determinations

Moisture content and dry density determinations were performed on select driven ring samples collected to evaluate the natural water content and dry density of the various soils encountered in accordance with ASTM D7263. In addition, moisture contents were determined on select collected bulk samples in accordance with ASTM D2216. The results are presented on Table B-1 – Summary of Laboratory Test Results, and on the respective boring logs in Appendix A.

Grain Size Distribution

Four tests were performed to determine the amount of material in soils finer than the No. 200 Sieve in accordance with ASTM test method D1140. The results are presented in Table B-1 and in Figure B-1a – Grain Size Distribution Curves.

Atterberg Limits Tests

Atterberg limits tests were performed on four selected samples. Liquid and plastic limits were determined in accordance with standard test method ASTM D4318. The results are presented on Table B-1 and on Figure B-2 – Atterberg Limits' Results.

Direct Shear Tests

Multistage direct shear tests were performed on three representative driven ring samples to evaluate the shear strength of earth materials. The tests were performed in accordance with standard test method ASTM D3080. The results are presented on Table B-1 and on Figures B-3a and B-3c –Shear Test Diagram.

Consolidated Undrained Triaxial Tests

Four consolidated undrained triaxial compression tests were completed on representative driven samples to evaluate the strength of earth materials. Tests were performed in accordance with standard test method ASTM D4746. The results are presented on Figures B-4a through B-4d – Consolidated Undrained Triaxial Compression with Pore Pressure.

Maximum Unit Weight/Optimum Moisture Content Tests

Maximum unit weight and optimum moisture content tests were performed on two select samples of near surface onsite soils to assess their compaction characteristics. The tests were performed in accordance with ASTM D1557, and the results are presented on Table B-1 and on Figures B-5a and B-5b – Moisture-Density Relationship.

Soil Chemistry Tests/Corrosion Tests

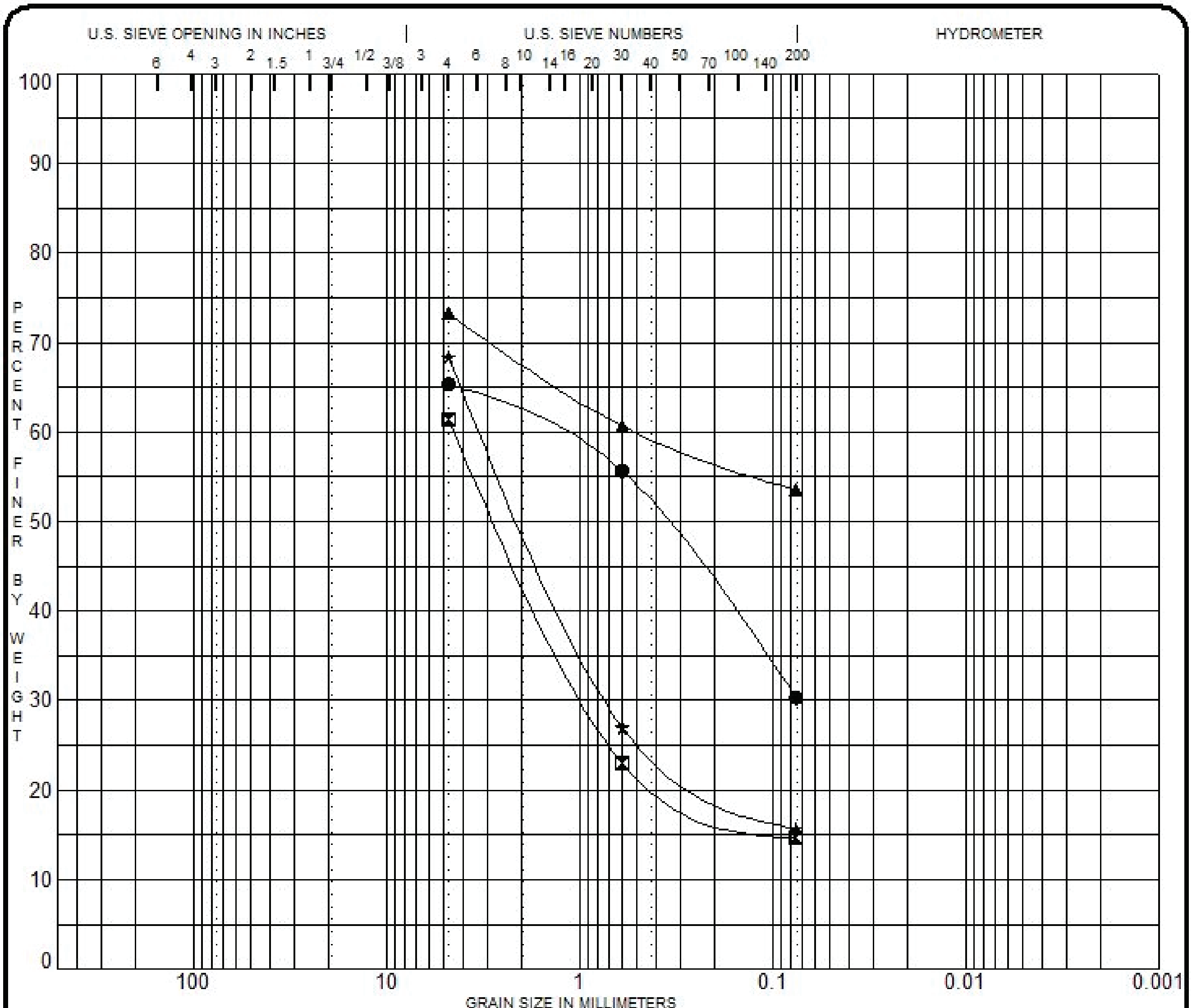
A soil corrosion suite was performed on a select near surface sample to evaluate resistivity, pH, sulfate, and chloride. Results of the testing and a preliminary analysis of the corrosivity to reinforcement steel and concrete materials are presented on Table B-1 and are summarized in the main report.

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth	USCS	Moisture Content	In-Situ Moist Unit Weight	In-Situ Dry Unit Weight	Passing #200 Sieve	Atterberg Limits LL	PL	Peak Shear Strength		Maximum Unit Weight / Optimum Moisture Content		Corrosion Potential			
No.	(feet)	Symbol	(%)	(pcf)	(pcf)	(%)	(%)	(%)	ϕ (deg)	c (psf)	Unit Weight (pcf)	Moisture (%)	Resistivity (ohm)	pH	Chorides (%)	Sulfates (%)
B-1	0-5		14.6	--	--	--	--	--	--	--	123.3	11.9	--	--	--	--
B-1	3.5		6.4	121.3	114.0	--	--	--	--	--	--	--	--	--	--	--
B-1	6.0		12.6	109.2	97.0	--	--	--	38	80	--	--	--	--	--	--
B-1	11.0		11.5	132.4	118.7	--	--	--	36	80	--	--	--	--	--	--
B-1	16.0		6.7	113.2	106.1	--	--	--	--	--	--	--	--	--	--	--
B-1	20.0		6.6	117.0	109.8	--	--	--	--	--	--	--	--	--	--	--
B-1	26.0		11.0	124.9	112.5	--	--	--	--	--	--	--	--	--	--	--
B-2	6.0		4.8	110.4	105.3	14.7	28	18	--	--	--	--	3,100	6.3	0.009	0.001
B-2	11.0		6.4	135.1	127.0	--	--	--	--	--	--	--	--	--	--	--
B-2	16.0		2.8	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	21.0		2.1	131.6	128.9	--	--	--	--	--	--	--	--	--	--	--
B-3	2.5		2.4	114.9	112.2	--	--	--	--	--	--	--	--	--	--	--
B-3	5.0		4.5	120.7	115.5	--	--	--	32	300	--	--	--	--	--	--
B-3	10.0		4.8	--	--	--	--	--	--	--	--	--	--	--	--	--
B-4	0-5		15.1	--	--	--	--	--	--	--	121.2	13.3	--	--	--	--
B-4	3.5		8.6	125.5	115.6	--	--	--	--	--	--	--	--	--	--	--
B-4	16.0		8.3	--	--	--	--	--	--	--	--	--	--	--	--	--
B-4	20.0		10.2	127.5	115.7		--	--	--	--	--	--	--	--	--	--
B-5	3.5		3.6	113.3	109.4	53.5	19	17	--	--	--	--	6,200	6.3	0.008	0.001
B-5	5.5		3.4	--	--	--	--	--	--	--	--	--	--	--	--	--
B-6	3.5		4.4	128.2	122.8	--	--	--	--	--	--	--	--	--	--	--
B-6	6.0		7.6	129.8	120.6	--	--	--	--	--	--	--	--	--	--	--
B-6	16.0		11.6	131.9	118.2	--	--	--	--	--	--	--	--	--	--	--
B-6	21.0		9.6	128.7	117.4	--	--	--	--	--	--	--	--	--	--	--

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS

Boring No.	Depth (feet)	USCS Symbol	Moisture Content (%)	In-Situ Moist Unit Weight (pcf)	In-Situ Dry Unit Weight (pcf)	Passing #200 Sieve (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)	Peak Shear Strength ϕ (deg)	Peak Shear Strength c (psf)	Maximum Unit Weight / Optimum Moisture Content: Unit Weight (pcf)	Maximum Unit Weight / Optimum Moisture Content: Moisture (%)	Corrosion Potential: Resistivity (ohm)	Corrosion Potential: pH	Corrosion Potential: Chorides (%)	Corrosion Potential: Sulfates (%)
B-7	3.5		15.5	124.4	107.7	--	--	--	--	--	--	--	--	--	--	--
B-7	6.0		11.6	132.9	119.1	--	--	--	21	200	--	--	--	--	--	--
B-7	11.0		7.1	116.4	108.7	--	--	--	--	--	--	--	--	--	--	--
B-7	15.0		4.7	121.5	116.0	--	--	--	--	--	--	--	--	--	--	--
B-8	6.0		7.7	127.0	117.9	15.7	26	18	--	--	--	--	3,300	6.1	0.006	0.001
B-8	10.5		4.8	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9	0-5		3.3	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9	3.5		7.6	116.2	108.0	--	--	--	--	--	--	--	--	--	--	--
B-9	6.0		12.0	115.6	103.2	--	--	--	--	--	--	--	--	--	--	--
B-9	23.5		7.3	137.1	127.8	--	--	--	28	80	--	--	--	--	--	--
B-9	26.0		3.6	122.2	118.0	--	--	--	--	--	--	--	--	--	--	--
B-10	3.0		7.6	116.4	108.2	--	--	--	--	--	--	--	--	--	--	--
B-10	11.0		3.4	120.6	116.6	30.3	25	15	--	--	--	--	2,700	6.4	0.008	0.001
B-10	16.0		7.9	--	--	--	--	--	--	--	--	--	--	--	--	--
B-10	20.0		5.2	126.5	120.2	--	--	--	35	350	--	--	--	--	--	--
TP-01	5.0		6.3	109.7	103.2	--	--	--	35	400	--	--	--	--	--	--



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		USCS Classification	MC%	LL	PL	PI	Cc	Cu
●	B-10	11.0		3	25	15	9		
⊠	B-2	6.0		5	28	18	10		
▲	B-5	3.5		4	19	17	2		
★	B-8	6.0		8	26	18	8		

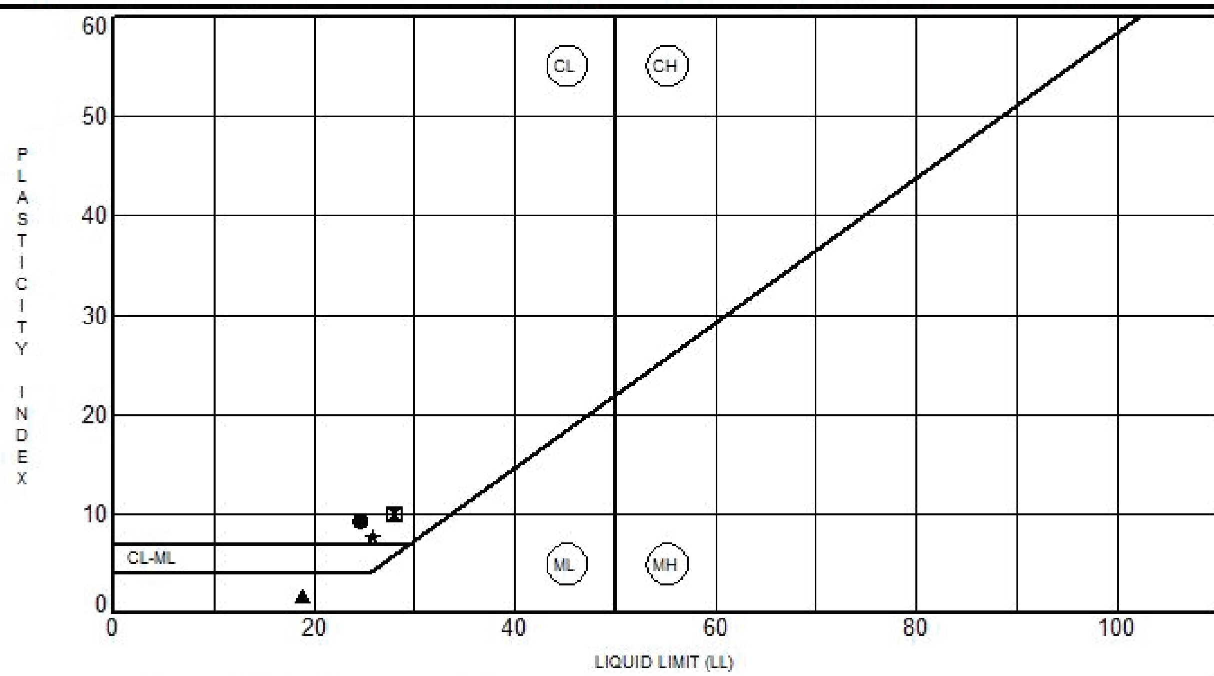
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	B-10	11.0	4.75	1.52			34.7	35.0	30.3
⊠	B-2	6.0	4.75	4.42	0.875		38.6	46.7	14.7
▲	B-5	3.5	4.75	0.50			26.7	19.8	53.5
★	B-8	6.0	4.75	3.13	0.697		31.6	52.7	15.7

PROJECT - VCPWA - Yerba Buena Road Slope Repairs

GRADATION CURVES
VCPWA - Yerba Buena Road Distress
County of Ventura, California

FIGURE B-1

PROJECT LOCATION: VCPWA - Yerba Buena Road Slope Repairs PROJECT NO.: SC6164

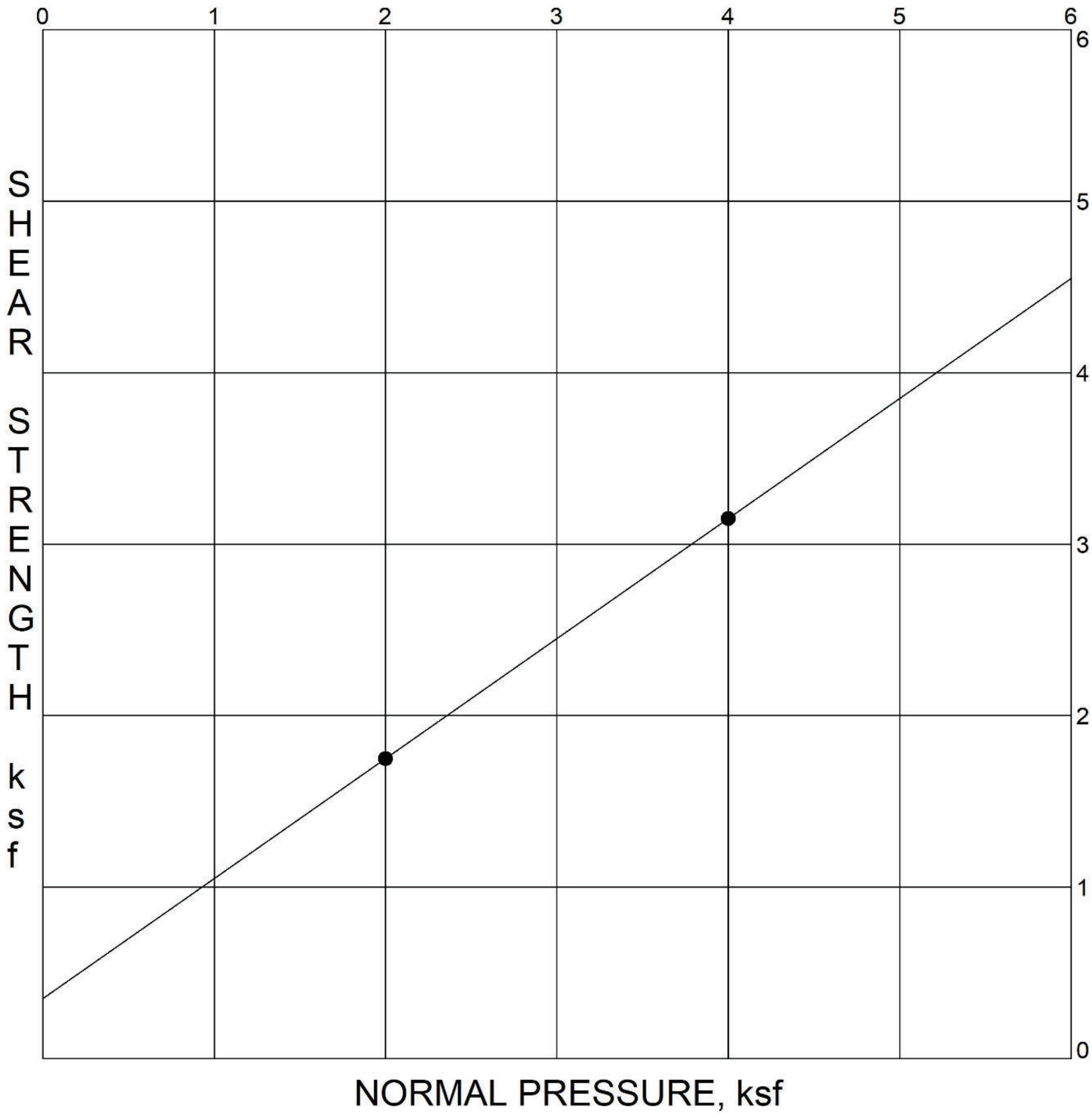


	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-10	11.0	25	15	10	30.3	CLAYEY SAND with GRAVEL SC
⊠	B-2	6.0	28	18	10	14.7	CLAYEY SAND with GRAVEL SC
▲	B-5	3.5	19	17	2	53.5	GRAVELLY SILT with SAND ML
★	B-8	6.0	26	18	8	15.7	CLAYEY SAND with GRAVEL SC

ATTERBERG LIMITS' RESULTS

PROJECT LOCATION: VCPWA - Yerba Buena Road Slope Repairs PROJECT NO.: SC6164

SAMPLE LOCATION: B-10 @ 20.0 DESCRIPTION:



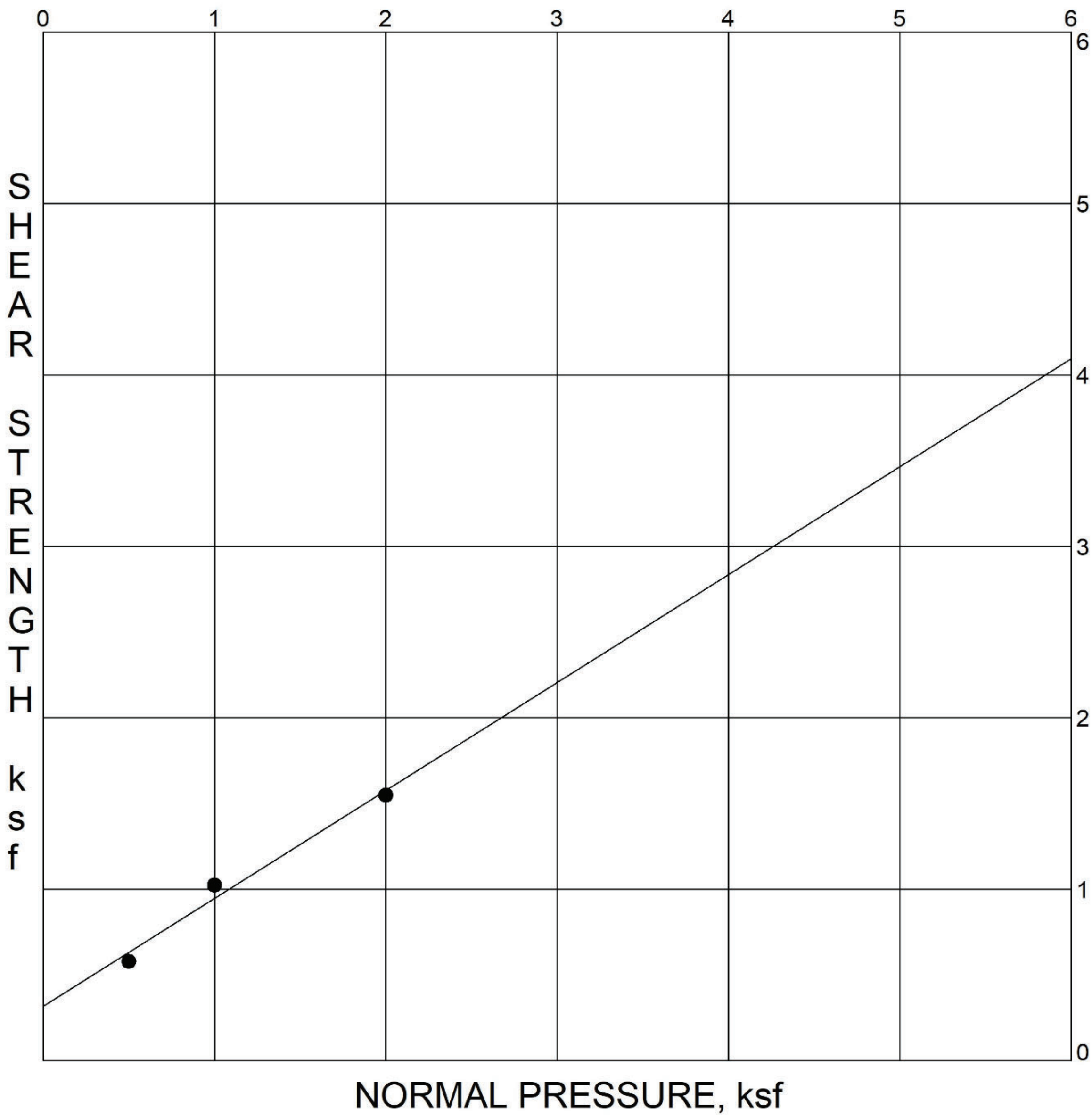
Test Results

Moisture Content (%)	Density (pcf)	Ultimate Strength
Insitu: 5.2	Dry Density: 120.2	Phi (deg): 35.0
Saturated: 14.9		Cohesion (ksf): 0.350

SHEAR TEST DIAGRAM

PROJECT LOCATION: VCPWA - Yerba Buena Road Slope Repairs PROJECT NO.: SC6164

SAMPLE LOCATION: B-3 @ 5.0 DESCRIPTION: MC



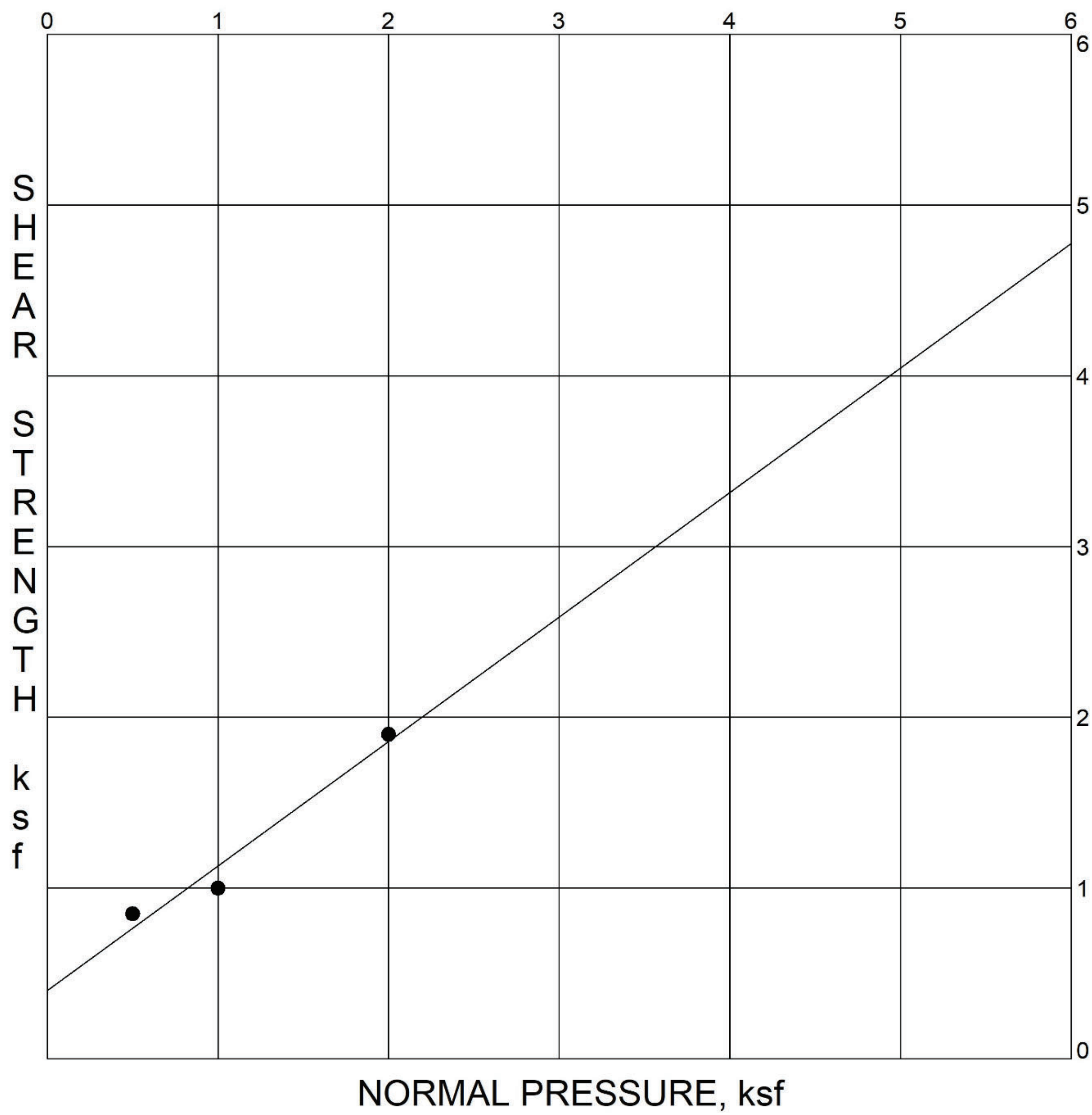
Test Results

Moisture Content (%)	Density (pcf)	Ultimate Strength
Insitu: 4.5	Dry Density: 115.5	Phi (deg): 32.0
Saturated: 17.0		Cohesion (ksf): 0.300

SHEAR TEST DIAGRAM

PROJECT LOCATION: VCPWA - Yerba Buena Road Slope Repairs PROJECT NO.: SC6164

SAMPLE LOCATION: TP-1 @ 5.0 DESCRIPTION:

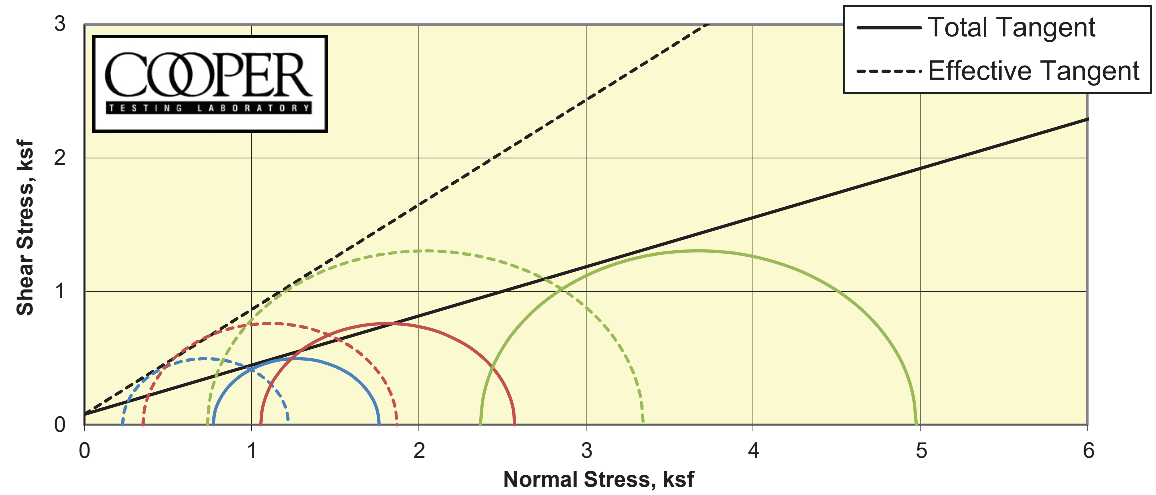


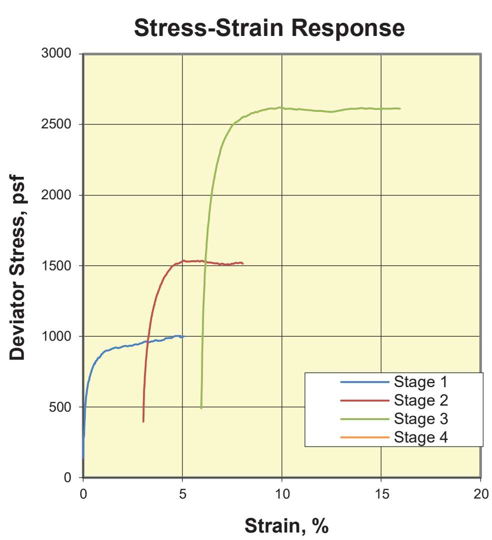
Test Results

Moisture Content (%)	Density (pcf)	Ultimate Strength
Insitu: 6.3	Dry Density: 106.2	Phi (deg): 35.0
Saturated: 21.8		Cohesion (ksf): 0.400

SHEAR TEST DIAGRAM

Staged Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767m

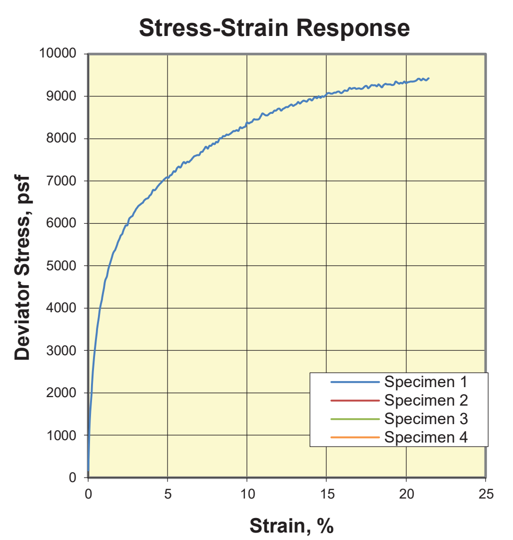




CTL Number:	026-798
Client Name:	Cotton, Shires & Associates
Project Name:	VCPWA-Yerba Buena Road Slope Repairs
Project Number:	SC6164
Date:	3/5/2025 By: MD/DC
Total C	0.080 ksf
Total phi	20.2 degrees
Eff. C	0.080 ksf
Eff. Phi	38.1 degrees ©

Stage	1	2	3	4
Boring	B-1			
Sample	3			
Depth	6-6.5			
Visual Description	Reddish Brown Sandy CLAY w/ Gravel			
MC (%)	12.6			
Dry Density (pcf)	97.0			
Saturation (%)	48.8			
Void Ratio	0.674			
Diameter (in)	2.40			
Height (in)	5.00			
	Final			
MC (%)	24.9	23.3	21.4	
Dry Density (pcf)	98.6	101.1	104.3	
Saturation (%)	100.0	100.0	100.0	
Void Ratio	0.646	0.605	0.557	
Diameter (in)	2.38	2.39	2.39	
Height (in)	5.00	4.84	4.70	
Cell Pressure (psi)	124.0	125.8	132.3	
Back Pressure (psi)	118.6	118.5	115.8	
	Effective Stresses At:			
Strain (%)	5.0	5.0	5.0	
Deviator (ksf)	0.993	1.520	2.609	
Excess PP (psi)	3.8	4.9	11.3	
Sigma 1 (ksf)	1.220	1.869	3.343	
Sigma 3 (ksf)	0.227	0.349	0.735	
P (ksf)	0.724	1.109	2.039	
Q (ksf)	0.496	0.760	1.304	
Stress Ratio	5.364	5.356	4.550	
Rate (in/min)	0.0006	0.0006	0.0006	

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

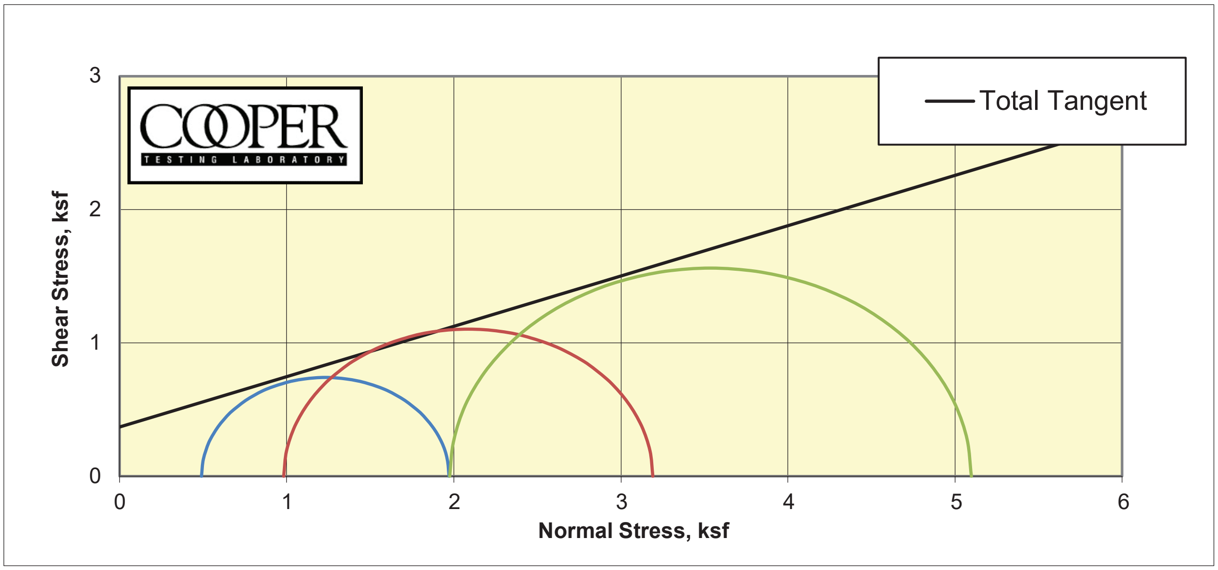


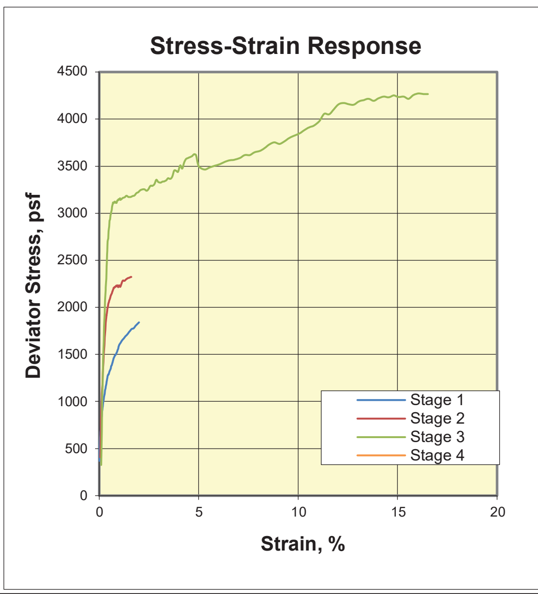
CTL Number:	026-798
Client Name:	Cotton, Shires & Associates
Project Name:	VCPWA-Yerba Buena Road Slope Repairs
Project Number:	SC6164
Date:	2/21/2025 By: MD/DC
Total C	ksf
Total phi	degrees
Eff. C	ksf
Eff. Phi	degrees

©

Specimen	1	2	3	4
Boring	B-1			
Sample				
Depth	11			
Visual Description	Olive Brown Sandy CLAY w/ Gravel			
MC (%)	11.5			
Dry Density (pcf)	118.7			
Saturation (%)	67.9			
Void Ratio	0.473			
Diameter (in)	2.42			
Height (in)	4.70			
	Final			
MC (%)	15.6			
Dry Density (pcf)	121.6			
Saturation (%)	100.0			
Void Ratio	0.437			
Diameter (in)	2.40			
Height (in)	4.67			
Cell Pressure (psi)	81.9			
Back Pressure (psi)	60.1			
	Effective Stresses At:			
Strain (%)	15.0			
Deviator (ksf)	9.022			
Excess PP (psi)	0.4			
Sigma 1 (ksf)	12.101			
Sigma 3 (ksf)	3.079			
P (ksf)	7.590			
Q (ksf)	4.511			
Stress Ratio	3.930			
Rate (in/min)	0.0005			

Staged Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767m



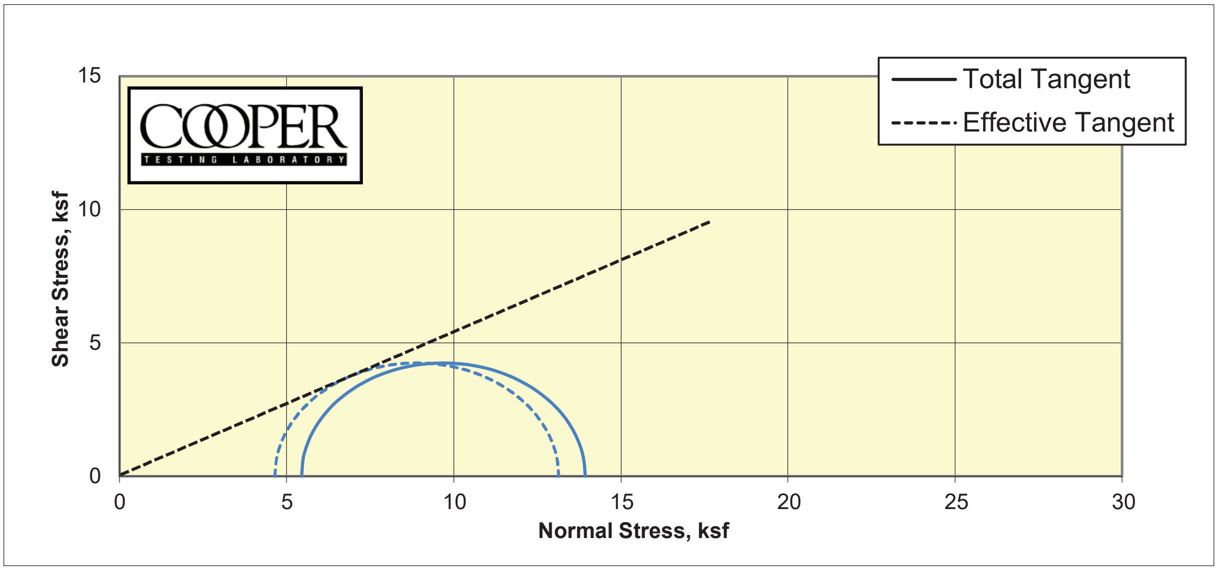


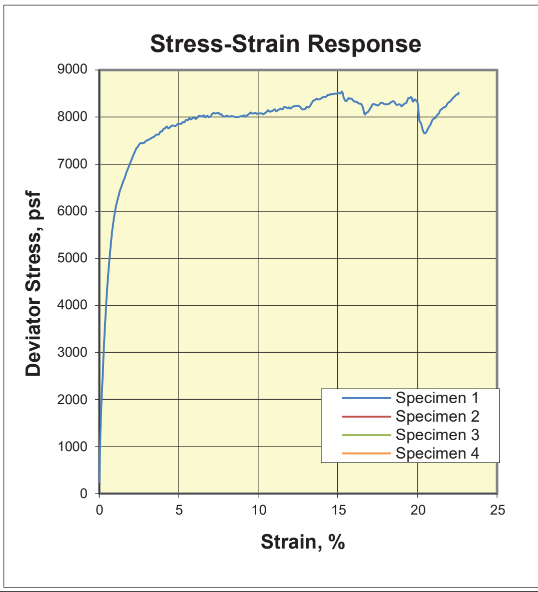
Stage	1	2	3	4
Boring	B-7			
Sample	2			
Depth	6-6.5			
Visual Description	Olive Brown Clayey SAND w/ Gravel			
MC (%)	11.6			
Dry Density (pcf)	119.1			
Saturation (%)	69.3			
Void Ratio	0.467			
Diameter (in)	2.40			
Height (in)	5.00			
	Final			
MC (%)	16.7	16.5	16.1	
Dry Density (pcf)	119.0	119.5	120.5	
Saturation (%)	100.0	100.0	100.0	
Void Ratio	0.468	0.462	0.451	
Diameter (in)	2.40	2.39	2.39	
Height (in)	5.01	5.00	5.00	
Cell Pressure (psi)	83.4	86.9	93.9	
Back Pressure (psi)	80.0	80.1	80.2	
	Effective Stresses At:			
Strain (%)	0.8	0.7	0.7	
Deviator (ksf)	1.483	2.208	3.121	
Excess PP (psi)	1.4	2.7	6.2	
Sigma 1 (ksf)	1.765	2.800	4.202	
Sigma 3 (ksf)	0.282	0.592	1.081	
P (ksf)	1.023	1.696	2.642	
Q (ksf)	0.741	1.104	1.561	
Stress Ratio	6.260	4.729	3.887	
Rate (in/min)	0.0006	0.0006	0.0006	

CTL Number:	026-798		
Client Name:	Cotton, Shires & Associates		
Project Name:	VCPWA-Yerba Buena Road Slope Repairs		
Project Number:	SC6164		
Date:	3/10/2025	By:	MD/DC
Total C	**0.370**	**ksf**	
Total phi	**20.7**	**degrees**	
Eff. C	**0.200**	**ksf**	
Eff. Phi	**31.0**	**degrees**	©

Remarks: Strengths picked at the peak effective stress ratios.

Consolidated Undrained Triaxial Compression with Pore Pressure
ASTM D4767

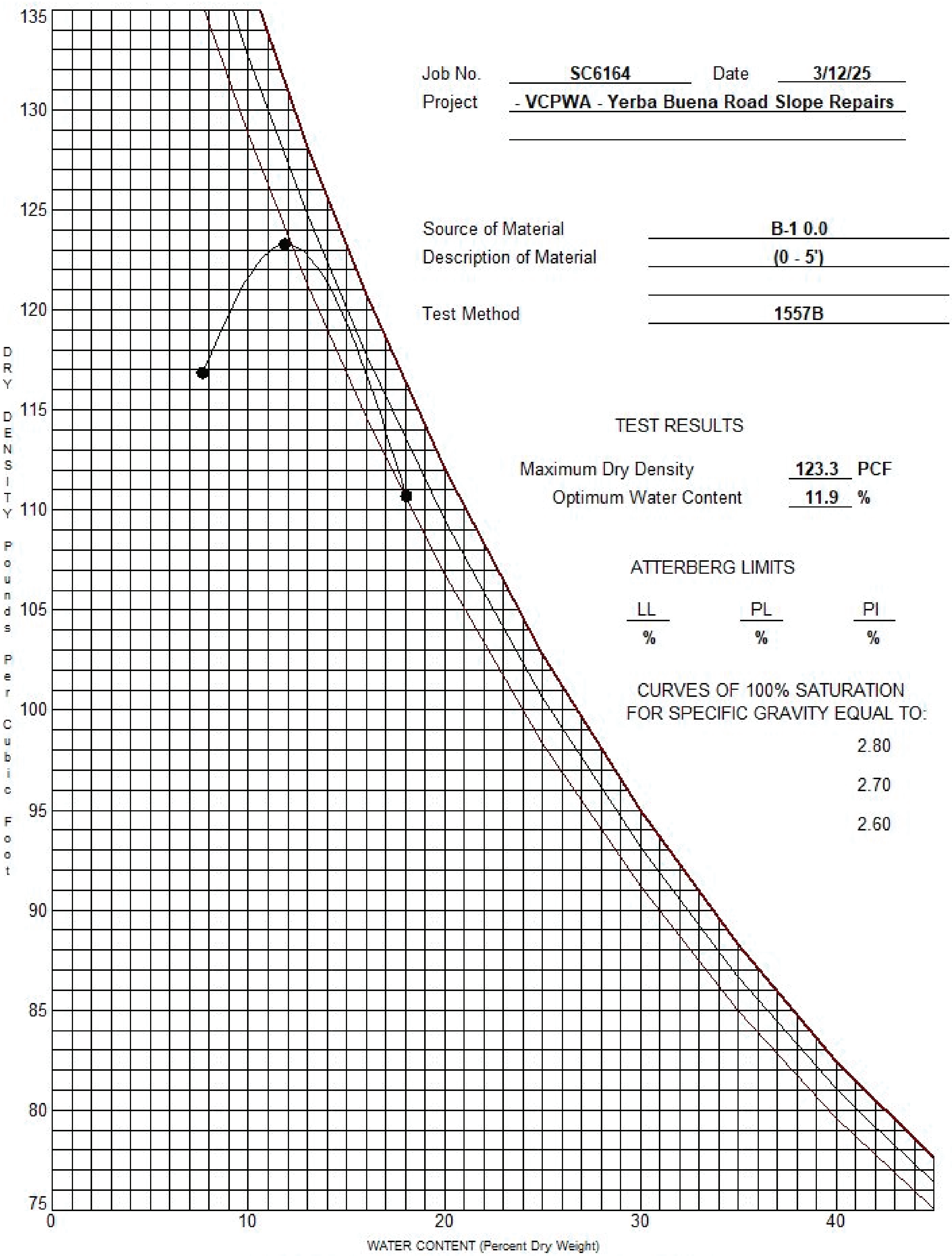




CTL Number:	026-798
Client Name:	Cotton, Shires & Associates
Project Name:	VCPWA-Yerba Buena Slope Repairs
Project Number:	SC6164
Date:	2/21/2025 By: MD/DC
Total C	ksf
Total phi	degrees
Eff. C	ksf
Eff. Phi	degrees

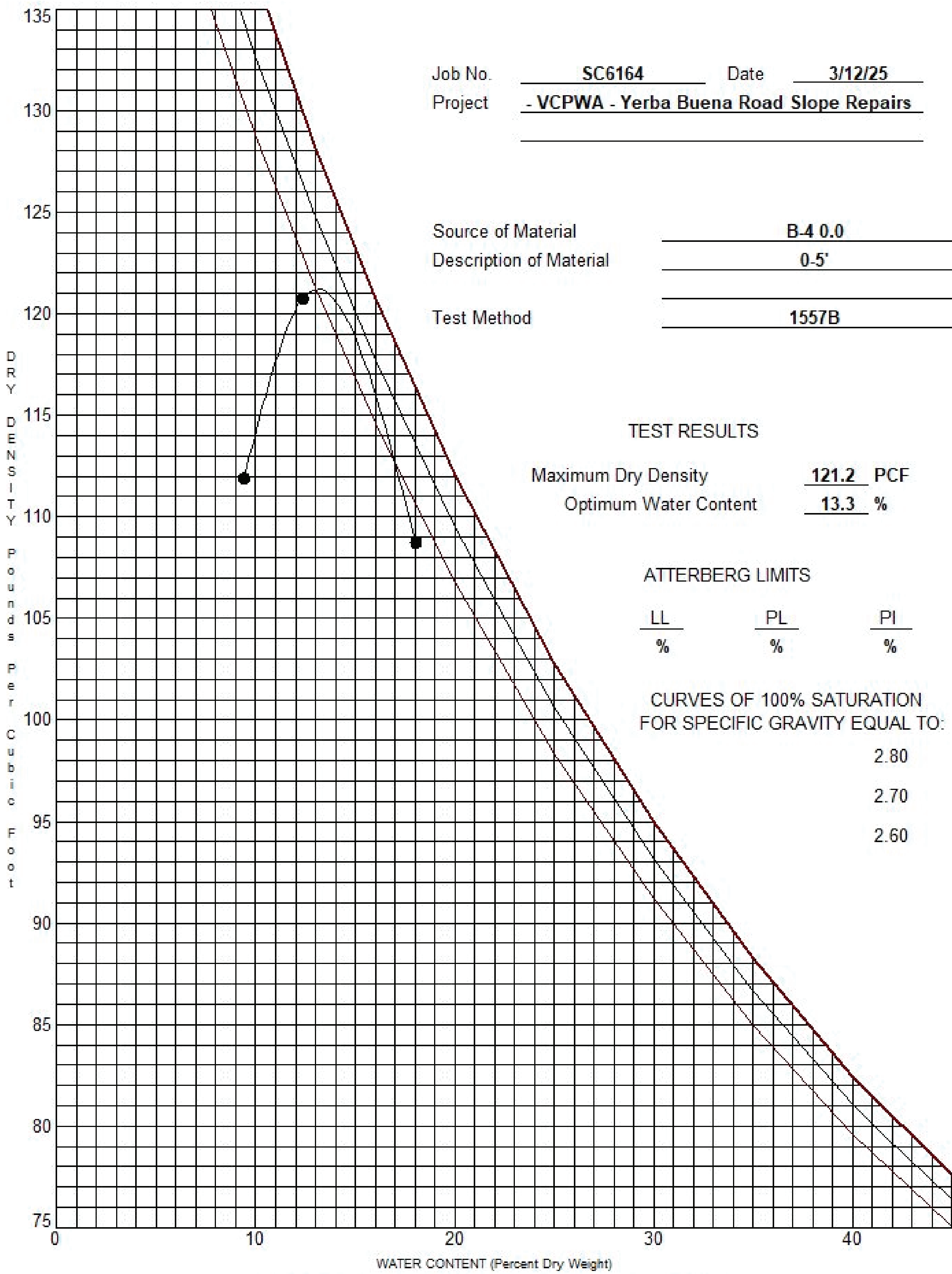
©

Specimen	1	2	3	4
Boring	B-9			
Sample				
Depth	23.5			
Visual Description	Yellowish Brown Clayey SAND w/ Gravel			
MC (%)	7.3			
Dry Density (pcf)	127.8			
Saturation (%)	56.0			
Void Ratio	0.367			
Diameter (in)	2.42			
Height (in)	5.00			
	Final			
MC (%)	11.7			
Dry Density (pcf)	131.7			
Saturation (%)	100.0			
Void Ratio	0.328			
Diameter (in)	2.40			
Height (in)	4.96			
Cell Pressure (psi)	97.2			
Back Pressure (psi)	59.4			
	Effective Stresses At:			
Strain (%)	15.0			
Deviator (ksf)	8.496			
Excess PP (psi)	5.5			
Sigma 1 (ksf)	13.137			
Sigma 3 (ksf)	4.641			
P (ksf)	8.889			
Q (ksf)	4.248			
Stress Ratio	2.830			
Rate (in/min)	0.0005			



MOISTURE-DENSITY RELATIONSHIP
VCPWA - Yerba Buena Road Distress
County of Ventura, California

FIGURE B-5a



MOISTURE-DENSITY RELATIONSHIP

VCPWA - Yerba Buena Road Distress
County of Ventura, California

FIGURE B-5b

APPENDIX C
SEISMIC DESIGN PARAMETERS

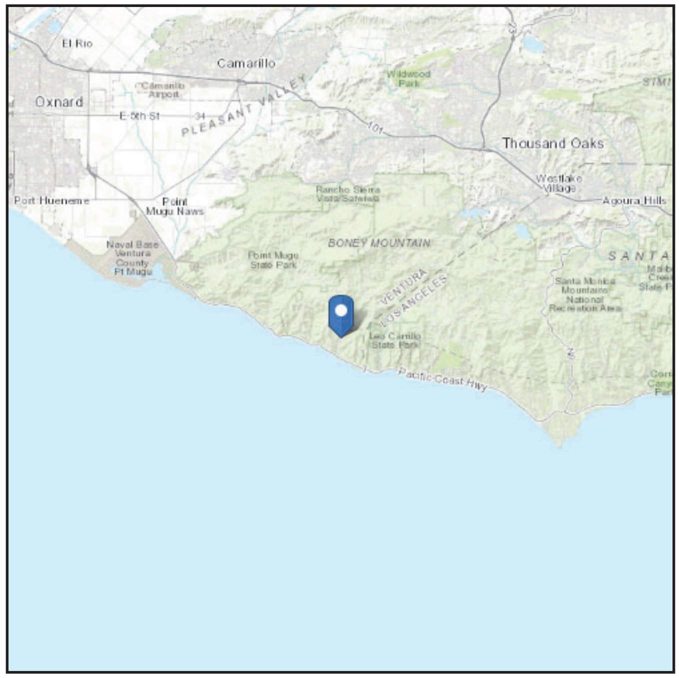
SC6164
MP 0.93

ASCE Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: C - Very Dense Soil and Soft Rock

Latitude: 34.065027
Longitude: -118.962648
Elevation: 297.3624947846284 ft (NAVD 88)



SC6164
MP 0.93

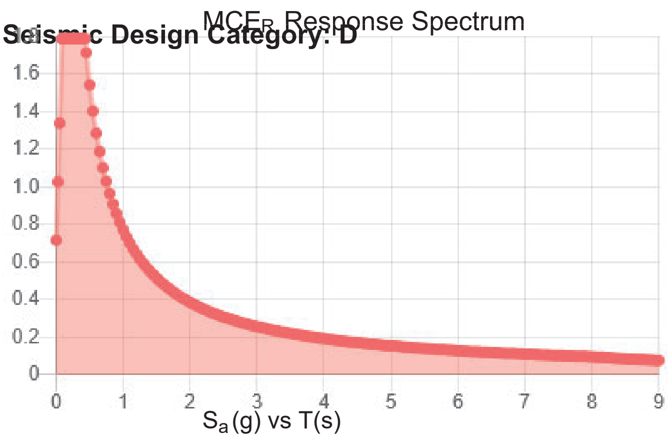
Seismic

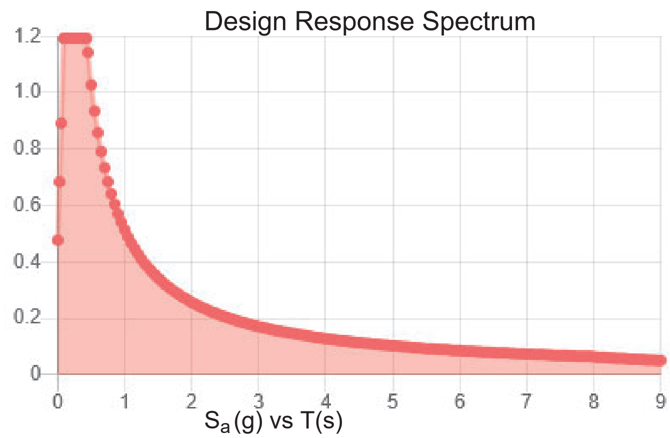
Site Soil Class: C - Very Dense Soil and Soft Rock

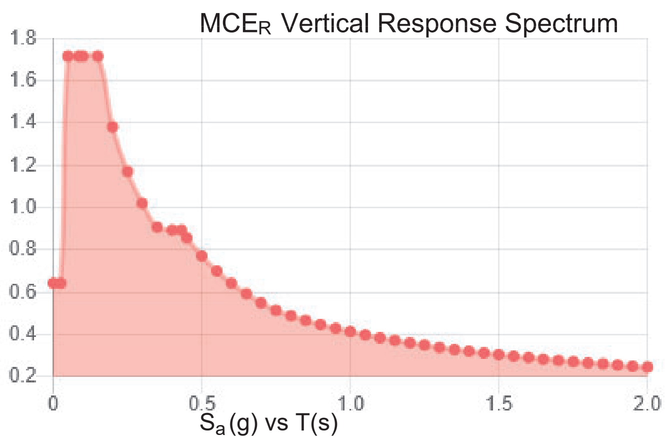
Results:

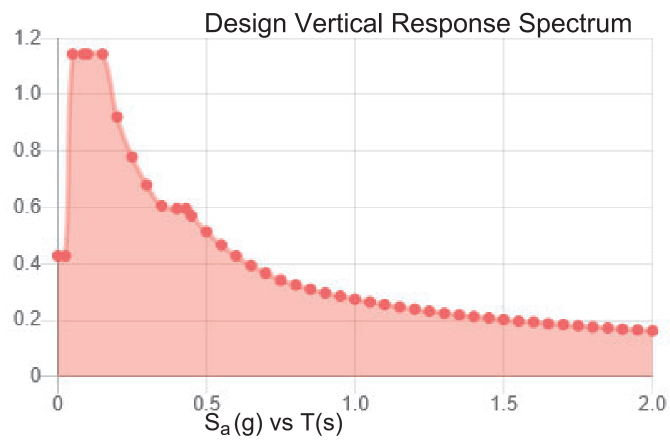
S_S :	1.491	S_{D1} :	0.514
S_1 :	0.521	T_L :	8
F_a :	1.2	PGA :	0.643
F_v :	1.479	PGA_M :	0.772
S_{MS} :	1.789	F_{PGA} :	1.2
S_{M1} :	0.771	I_e :	1
S_{DS} :	1.193	C_v :	1.198

Seismic Design Category: D









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.

Please also see the new USGS Earthquake Hazard Toolbox for access to the most recent NSHMs for the conterminous U.S. and Hawaii.

Input

Edition

Dynamic: Conterminous U.S. 2014 (…

Latitude

Decimal degrees

34.065027

Longitude

Decimal degrees, negative values for western longitudes

-118.962648

Site Class

537 m/s (Site class C)

Spectral Period

Peak Ground Acceleration

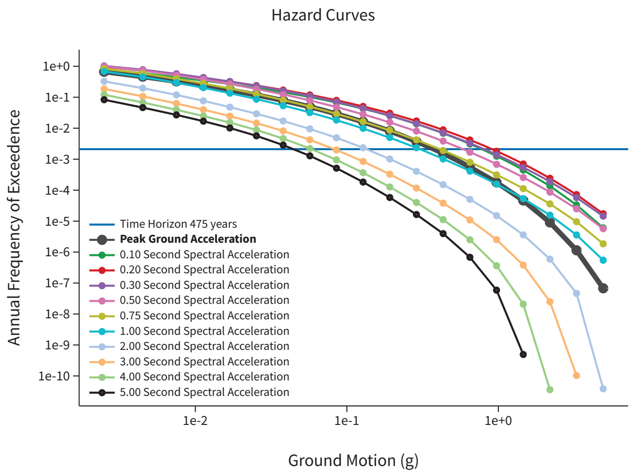
Time Horizon

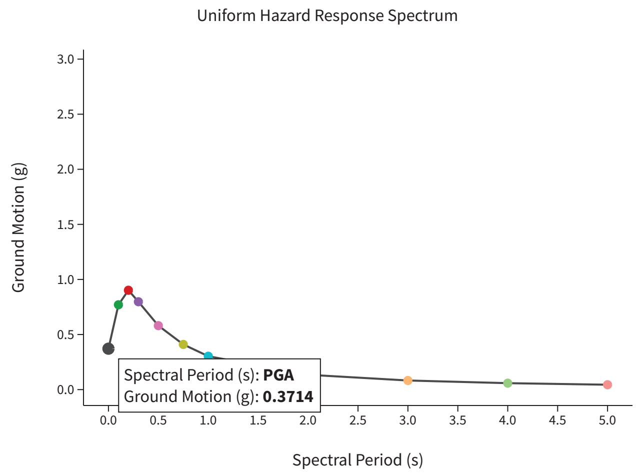
Return period in years

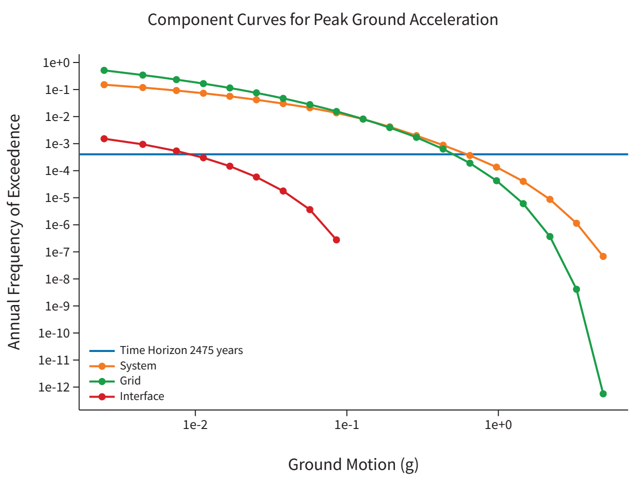
475

SC6164
MP 0.93

Hazard Curve







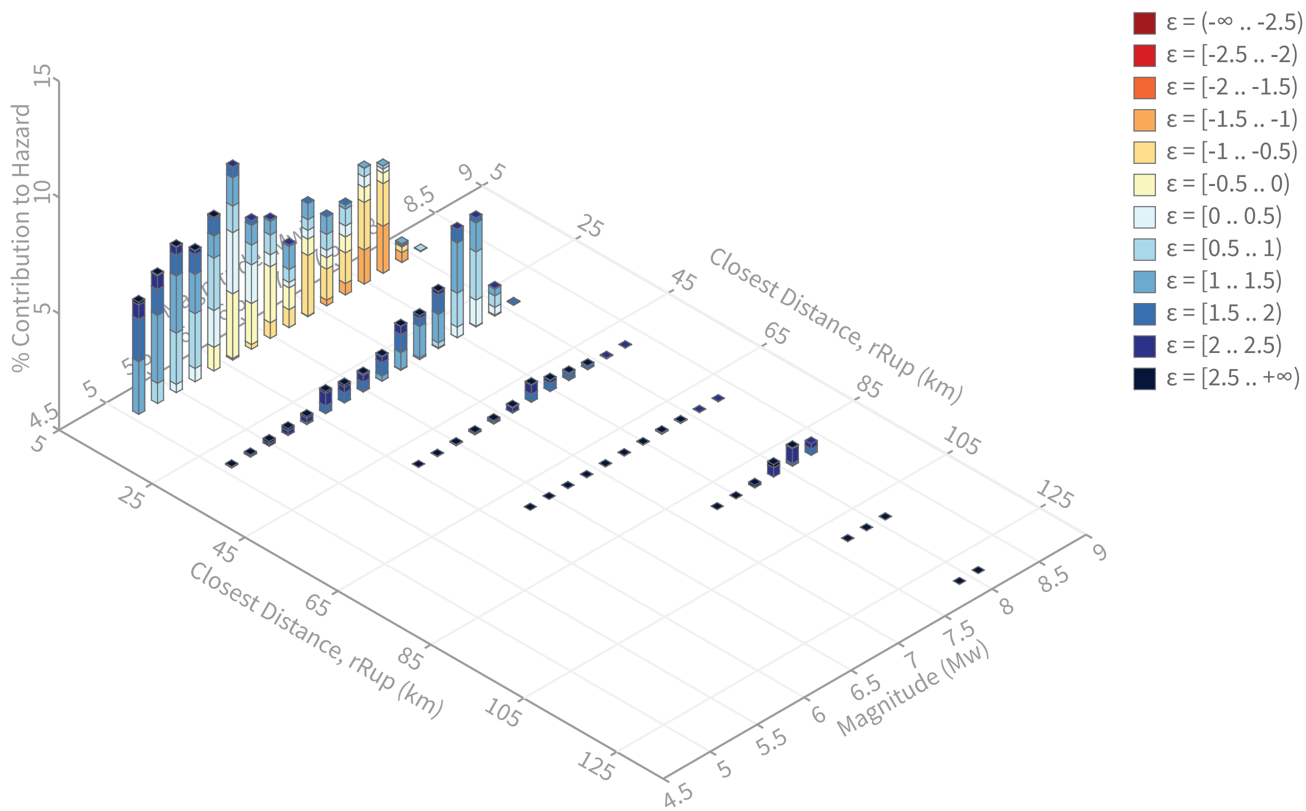
View Raw Data

SC6164
MP 0.93

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.37143435 g

Recovered targets

Return period: 505.57764 yrs
Exceedance rate: 0.0019779356 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 0.16 %

Mean (over all sources)

m: 6.57
r: 15.19 km
ε_0: 0.68 σ

Mode (largest m-r bin)

m: 6.11
r: 7.9 km
ε_0: 0.42 σ
Contribution: 8.3 %

Mode (largest m-r-ε_0 bin)

m: 5.3
r: 8.8 km
ε_0: 1.24 σ
Contribution: 2.92 %

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 .. +∞]

SC6164
MP 0.93

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							30.96
Malibu Coast alt 1 [9]		3.41	6.27	-0.21	118.933°W	34.048°N	124.17	6.73
Malibu Coast (Extension) alt 1 [0]		1.60	7.10	-0.88	118.964°W	34.052°N	185.20	4.11
Anacapa-Dume alt 1 [2]		8.61	7.33	-0.67	119.000°W	33.978°N	199.83	3.08
Simi-Santa Rosa [5]		19.95	7.10	1.02	118.999°W	34.241°N	350.31	2.17
Oak Ridge (Onshore) [0]		25.97	7.54	0.90	119.125°W	34.269°N	326.76	1.72
Sisar [1]		20.68	7.68	0.39	119.069°W	34.408°N	345.60	1.51
San Pedro Basin [11]		20.67	6.83	1.39	118.797°W	33.941°N	132.03	1.35
UC33brAvg_FM32	System							25.45
Anacapa-Dume alt 2 [5]		8.99	7.24	-0.66	118.998°W	33.974°N	197.80	4.73
Malibu Coast (Extension) alt 2 [0]		2.02	7.57	-1.02	118.965°W	34.055°N	189.64	3.33
Simi-Santa Rosa [5]		19.95	7.07	1.05	118.999°W	34.241°N	350.31	2.00
Malibu Coast alt 2 [4]		3.59	6.89	-0.54	118.933°W	34.051°N	120.06	1.98
Oak Ridge (Onshore) [0]		25.97	7.46	0.98	119.125°W	34.269°N	326.76	1.59
Sisar [1]		20.68	7.64	0.44	119.069°W	34.408°N	345.60	1.25
San Pedro Basin [11]		20.67	6.89	1.36	118.797°W	33.941°N	132.03	1.07
UC33brAvg_FM32 (opt)	Grid							21.80
PointSourceFinite: -118.963, 34.114		7.39	5.67	0.68	118.963°W	34.114°N	0.00	2.38
PointSourceFinite: -118.963, 34.114		7.39	5.67	0.68	118.963°W	34.114°N	0.00	2.38
PointSourceFinite: -118.963, 34.123		7.99	5.73	0.75	118.963°W	34.123°N	0.00	2.26
PointSourceFinite: -118.963, 34.123		7.99	5.73	0.75	118.963°W	34.123°N	0.00	2.26
PointSourceFinite: -118.963, 34.141		9.65	5.67	1.05	118.963°W	34.141°N	0.00	1.53
PointSourceFinite: -118.963, 34.141		9.65	5.67	1.05	118.963°W	34.141°N	0.00	1.53
PointSourceFinite: -118.963, 34.150		10.47	5.67	1.17	118.963°W	34.150°N	0.00	1.39
PointSourceFinite: -118.963, 34.150		10.47	5.67	1.17	118.963°W	34.150°N	0.00	1.39
UC33brAvg_FM31 (opt)	Grid							21.79
PointSourceFinite: -118.963, 34.114		7.40	5.65	0.71	118.963°W	34.114°N	0.00	2.60
PointSourceFinite: -118.963, 34.114		7.40	5.65	0.71	118.963°W	34.114°N	0.00	2.60
PointSourceFinite: -118.963, 34.123		8.04	5.70	0.78	118.963°W	34.123°N	0.00	2.32
PointSourceFinite: -118.963, 34.123		8.04	5.70	0.78	118.963°W	34.123°N	0.00	2.32
PointSourceFinite: -118.963, 34.141		9.53	5.70	1.00	118.963°W	34.141°N	0.00	1.41
PointSourceFinite: -118.963, 34.141		9.53	5.70	1.00	118.963°W	34.141°N	0.00	1.41
PointSourceFinite: -118.963, 34.150		10.36	5.70	1.13	118.963°W	34.150°N	0.00	1.20
PointSourceFinite: -118.963, 34.150		10.36	5.70	1.13	118.963°W	34.150°N	0.00	1.20

SC6164
MP 1.94

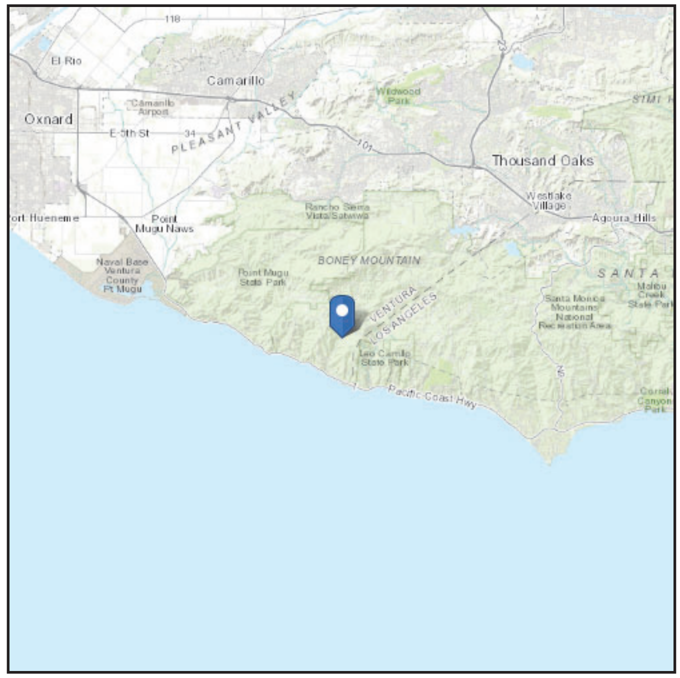
AMERICAN SOCIETY OF CIVIL ENGINEERS

ASCE Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: C - Very Dense Soil and Soft Rock

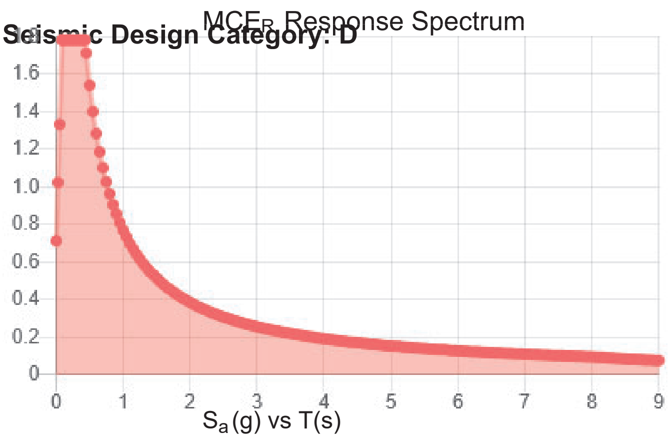
Latitude: 34.075253
Longitude: -118.954545
Elevation: 624.1705485955041 ft (NAVD 88)

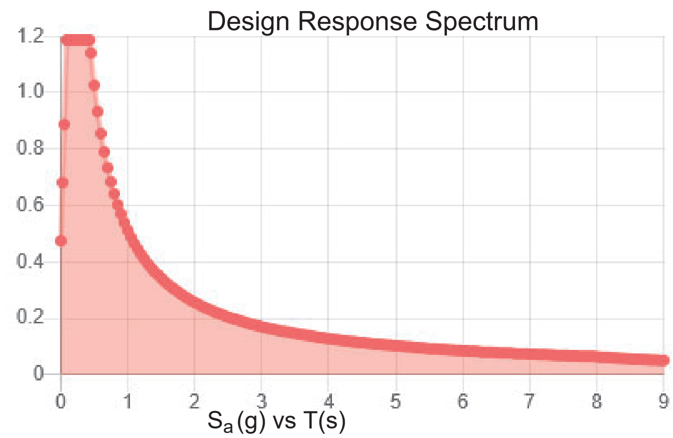


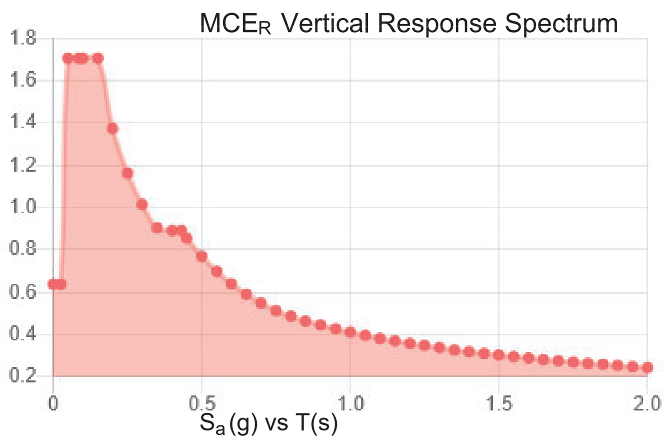
Seismic

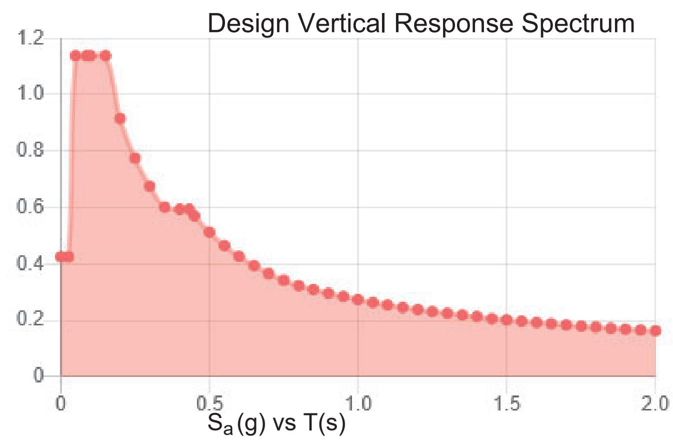
Site Soil Class:	C - Very Dense Soil and Soft Rock		
Results:			
S_S :	1.484	S_{D1} :	0.513
S_1 :	0.52	T_L :	8
F_a :	1.2	PGA :	0.639
F_v :	1.48	PGA_M :	0.767
S_{MS} :	1.781	F_{PGA} :	1.2
S_{M1} :	0.769	I_e :	1
S_{DS} :	1.187	C_v :	1.197

Seismic Design Category: D









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.

Please also see the new USGS Earthquake Hazard Toolbox for access to the most recent NSHMs for the conterminous U.S. and Hawaii.

Input

Edition

Dynamic: Conterminous U.S. 2014 (…

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

34.075253

Time Horizon

Return period in years

475

Longitude

Decimal degrees, negative values for western longitudes

-118.954545

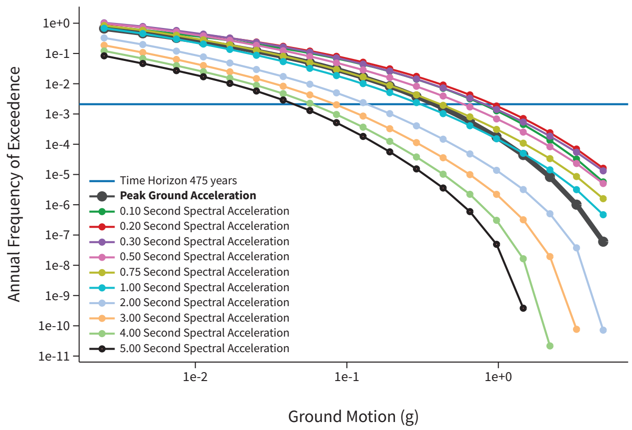
Site Class

537 m/s (Site class C)

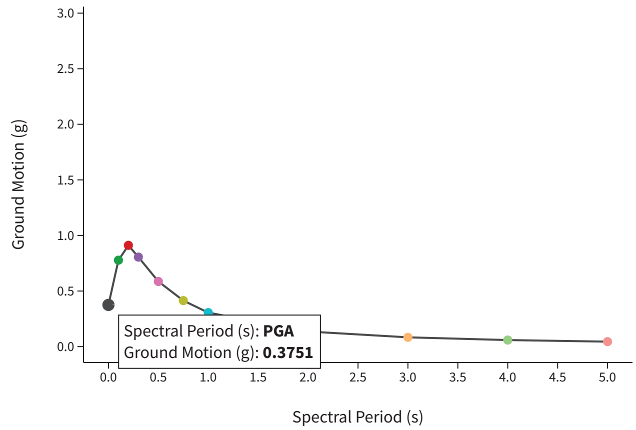
SC6164
MP 1.94

Hazard Curve

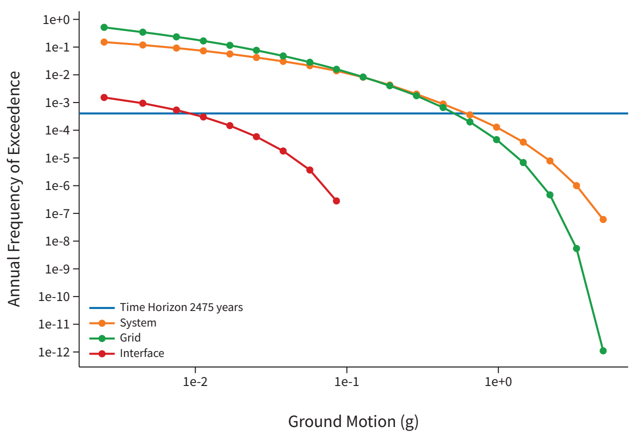
Hazard Curves



Uniform Hazard Response Spectrum



Component Curves for Peak Ground Acceleration



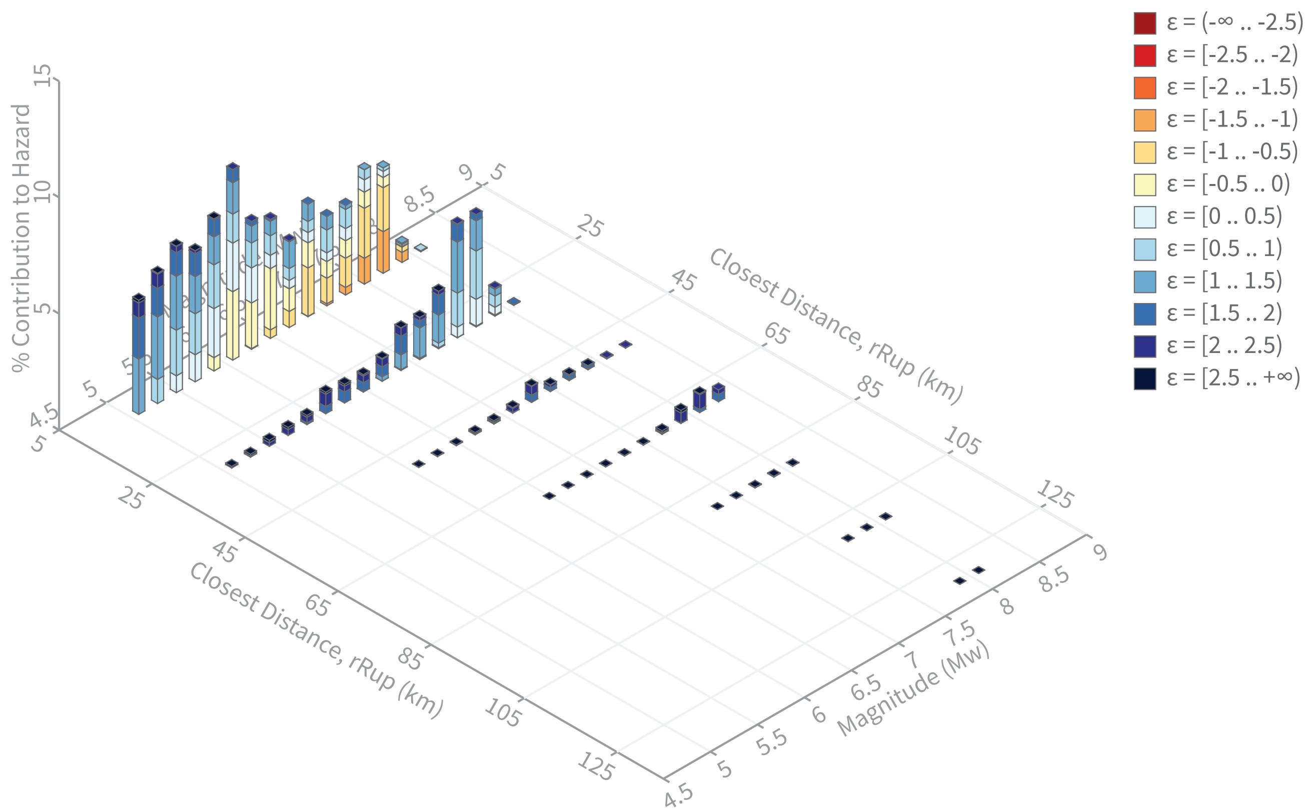
[View Raw Data]

SC6164
MP 1.94

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.37505034 g

Recovered targets

Return period: 505.45355 yrs
Exceedance rate: 0.00197%4212 yr^{-1}

Totals

Binned: 100 k
Residual: 0 k
Trace: 0.16 k

Mean (over all sources)

m: 6.57
r: 15.27 m8
ε_0: 0.7 σ

Mode (largest m-r bin)

m: 6.11
r: %11 m8
ε_0: 0.45 σ
Contribution: %19 k

Mode (largest m-r-ε_0 bin)

m: 6.13
r: 4.22 m8
ε_0: i0.13 σ
Contribution: 2.94 k

Discretization

r: 8 ╒ , 0.0a8 x- , 1000.0aΔ , 20.0 m8
m: 8 ╒ , 4.4a8 x- , 9.4aΔ , 0.2
ε: 8 ╒ , i3.0a8 x- , 3.0aΔ , 0.5 σ

Epsilon keys

ε0: [i∞ .. i2.5)
ε1: [i2.5 .. i2.0)
ε2: [i2.0 .. i1.5)
ε3: [i1.5 .. i1.0)
ε4: [i1.0 .. i0.5)
ε5: [i0.5 .. 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 .. +∞]

SC6164
MP 1.94

Deaggregation Contributors

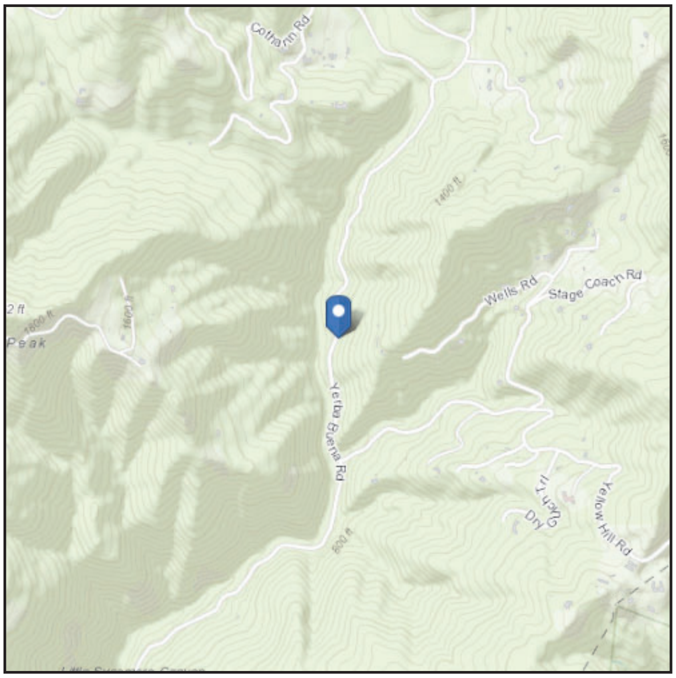
Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							30.96
Malibu Coast alt 1 [] 4		3.9]	9.27	-0.1]	118.] 33°W	36.068°N	169.3(	9.92
Malibu Coast Exnte) sio) 5alt 1 [04		2.73	7.11	-0.80	118.] (6°W	36.0(2°N	178.1(	3.] 9
A) acapa-Dume alt 1 [24		] .(7	7.32	-0.( ]	118.]] 1°W	33.] 79°N	1] 9.82	2.] (
Simi-Sa) ta Rosa [(4		18.] 8	7.10	0.] 8	118.]]] °W	36.261°N	367.(0	2.3(
Oak Ridge EO) shore5[04		2(.((	7.(3	0.8]	11] .12(°W	36.29] °N	326.0]	1.73
Sisar [14		20.28	7.98	0.39	11] .09] °W	36.608°N	366.11	1.((
Sa) Pedro Basi) [114		20.] 2	9.86	1.62	118.7] 7°W	33.] 61°N	13(.76	1.29
Oak Ridge EO) shore5[34		30.(6	7.(7	1.13	118.] 2] °W	36.392°N	6.1(	1.06
UC33brAvg_FM32	System							2(.21
A) acapa-Dume alt 2 [(4		] .] 0	7.2(	-0.6]	118.]] 8°W	33.] 76°N	1]] .((	6.39
Malibu Coast Exnte) sio) 5alt 2 [04		2.8]	7.(7	-1.00	118.] (6°W	36.0(6°N	178.8]	3.32
Simi-Sa) ta Rosa [(4		18.] 8	7.09	1.01	118.]]] °W	36.261°N	367.(0	2.18
Malibu Coast alt 2 [64		3.78	9.8]	-0.(8	118.] 33°W	36.0(1°N	163.9(	2.01
Oak Ridge EO) shore5[04		2(.((	7.69	0.] 8	11] .12(°W	36.29] °N	326.0]	1.91
Sisar [14		20.28	7.96	0.61	11] .09] °W	36.608°N	366.11	1.28
Sa) Pedro Basi) [114		20.] 2	9.] 0	1.38	118.7] 7°W	33.] 61°N	13(.76	1.01
UC33brAvg_FM31 Eopt5	Grid							22.13
Poi) tSourceFi) ite: -118.] ((, 36.12(		7.3]	(.99	0.71	118.] ((°W	36.12(°N	0.00	(.2(
Poi) tSourceFi) ite: -118.] ((, 36.12(		7.3]	(.99	0.71	118.] ((°W	36.12(°N	0.00	(.2(
Poi) tSourceFi) ite: -118.] ((, 36.191		10.30	(.72	1.12	118.] ((°W	36.191°N	0.00	2.30
Poi) tSourceFi) ite: -118.] ((, 36.191		10.30	(.72	1.12	118.] ((°W	36.191°N	0.00	2.30
Poi) tSourceFi) ite: -118.] ((, 36.209		13.6]	9.06	1.28	118.] ((°W	36.209°N	0.00	1.17
Poi) tSourceFi) ite: -118.] ((, 36.209		13.6]	9.06	1.28	118.] ((°W	36.209°N	0.00	1.17
UC33brAvg_FM32 Eopt5	Grid							22.02
Poi) tSourceFi) ite: -118.] ((, 36.12(		7.37	(.9]	0.98	118.] ((°W	36.12(°N	0.00	6.] (
Poi) tSourceFi) ite: -118.] ((, 36.12(		7.37	(.9]	0.98	118.] ((°W	36.12(°N	0.00	6.] (
Poi) tSourceFi) ite: -118.] ((, 36.191		10.66	(.98	1.17	118.] ((°W	36.191°N	0.00	2.(7
Poi) tSourceFi) ite: -118.] ((, 36.191		10.66	(.98	1.17	118.] ((°W	36.191°N	0.00	2.(7
Poi) tSourceFi) ite: -118.] ((, 36.209		13.67	9.0(	1.27	118.] ((°W	36.209°N	0.00	1.19
Poi) tSourceFi) ite: -118.] ((, 36.209		13.67	9.0(	1.27	118.] ((°W	36.209°N	0.00	1.19

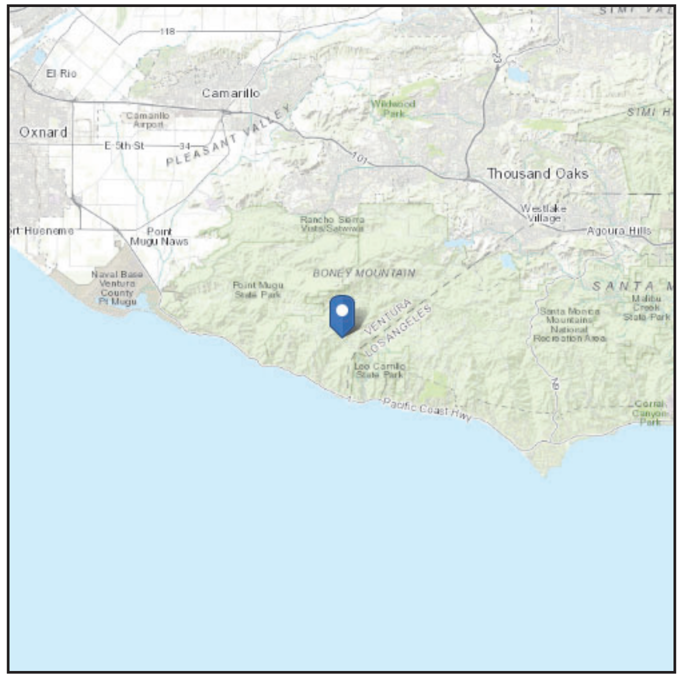
SC6164
MP 2.61

ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-16	**Latitude:**	34.082709
Risk Category:	II	**Longitude:**	-118.950912
Soil Class:	C - Very Dense Soil and Soft Rock	**Elevation:**	872.3554114389942 ft (NAVD 88)





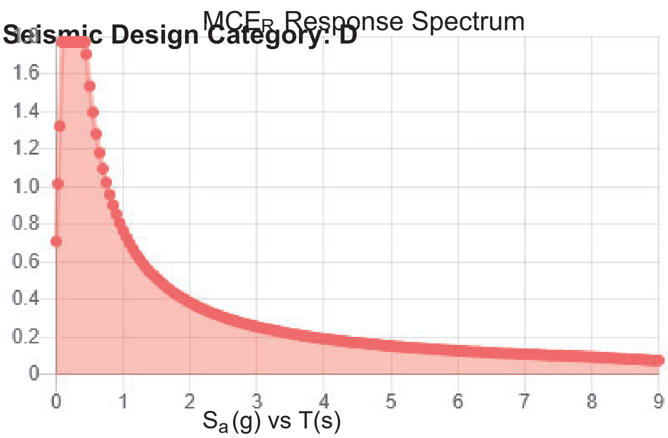
Seismic

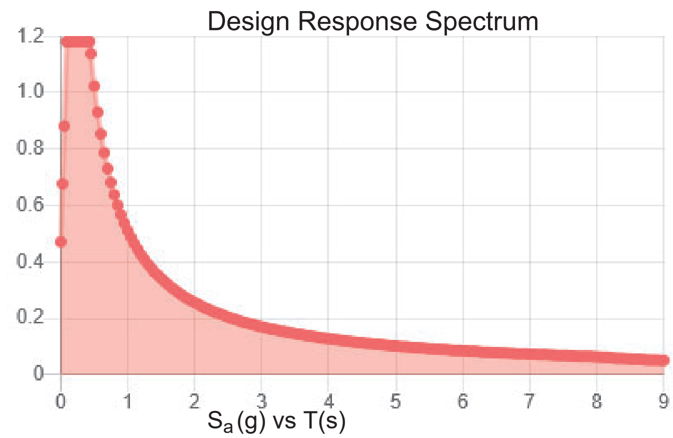
Site Soil Class: C - Very Dense Soil and Soft Rock

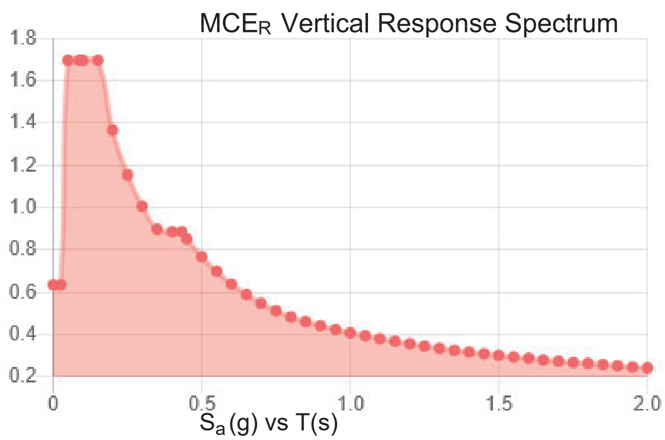
Results:

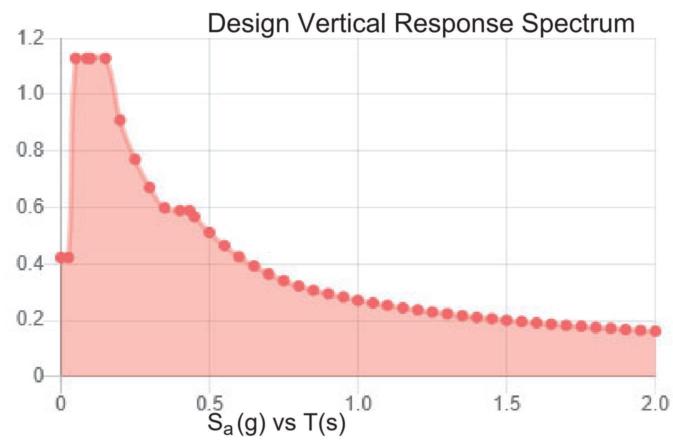
S_S :	1.476	S_{D1} :	0.512
S_1 :	0.518	T_L :	8
F_a :	1.2	PGA :	0.634
F_v :	1.482	PGA_M :	0.761
S_{MS} :	1.771	F_{PGA} :	1.2
S_{M1} :	0.767	I_e :	1
S_{DS} :	1.181	C_v :	1.195

Seismic Design Category: D









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.

Please also see the new USGS Earthquake Hazard Toolbox for access to the most recent NSHMs for the conterminous U.S. and Hawaii.

Input

Edition

Dynamic: Conterminous U.S. 2014 (…

Latitude

Decimal degrees

34.052708

Longitude

Decimal degrees, negative values for western longitudes

-115.890812

Site Class

937 m/s (Site class C)

Spectral Period

Peak Ground Acceleration

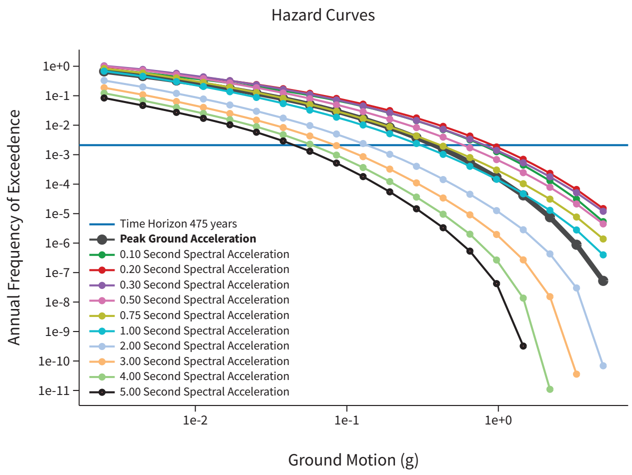
Time Horizon

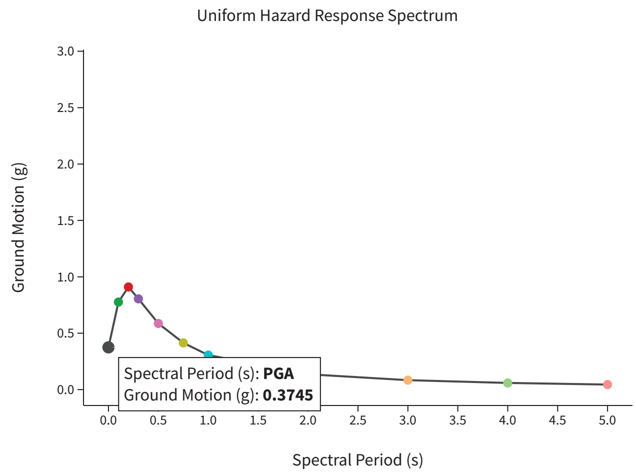
Return period in years

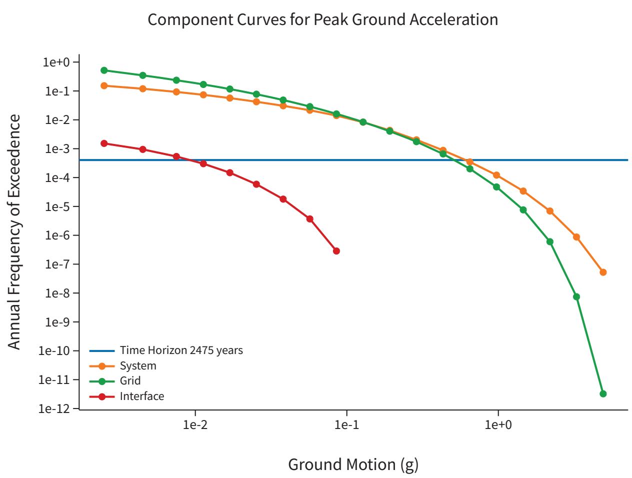
479

SC6164
MP 2.61

Hazard Curve







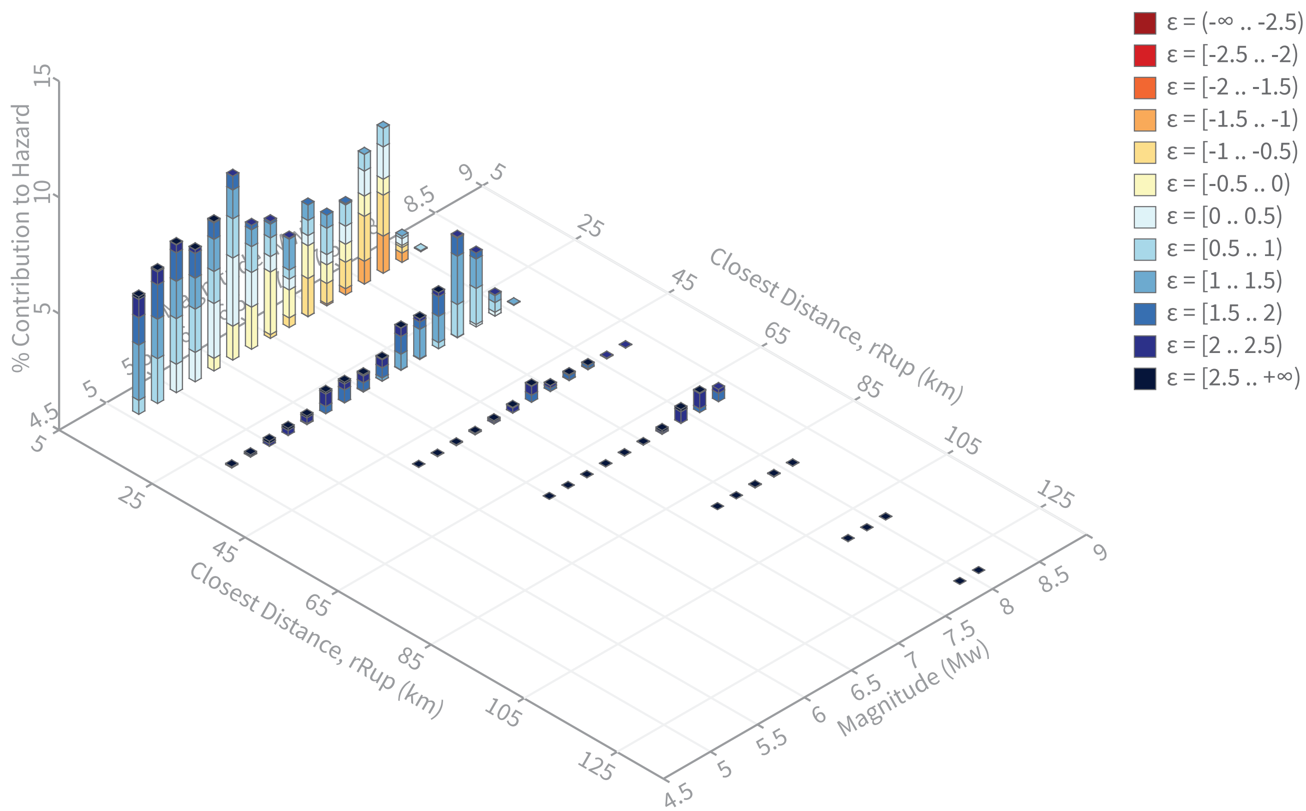
View Raw Data

SC6164
MP 2.61

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.37451g01 9

Recovered targets

Return period: 502.114%6 yrs
Exceedance rate: 0.001%91575g yr^{-1}

Totals

Binned: 100 k
Residual: 0 k
Trace: 0.16 k

Mean (over all sources)

m: 6.57
r: 15.52 m8
ε_0: 0.72 σ

Mode (largest m-r bin)

m: 6.11
r: g.45 m8
ε_0: 0.4%σ
Contribution: 7.%1 k

Mode (largest m-r-ε_0 bin)

m: 6.12
r: 5.4g m8
ε_0: 0.15 σ
Contribution: 2.%3 k

Discretization

r: 8 in = 0.0, 8 ax = 1000.0, Δ = 20.0 m8
m: 8 in = 4.4, 8 ax = %4, Δ = 0.2
ε: 8 in = -3.0, 8 ax = 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 .. +∞]

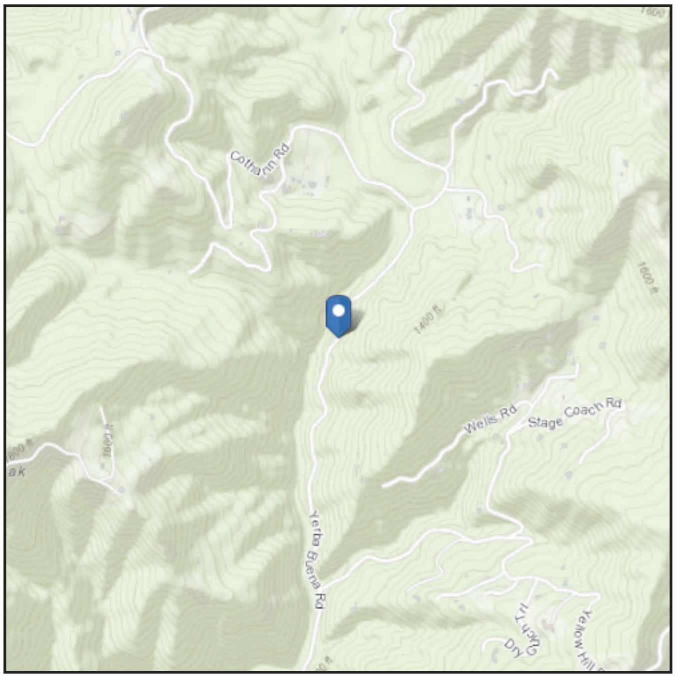
Deaggregation Contributors

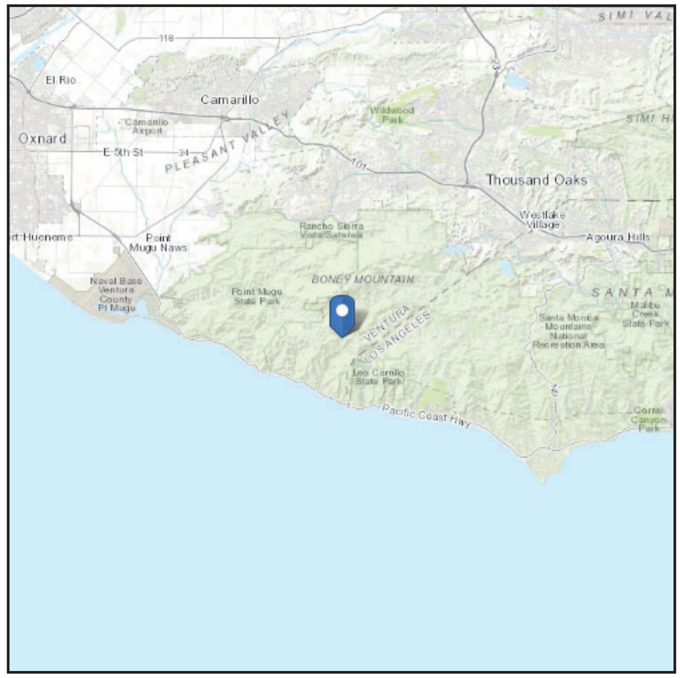
Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
UC33brAvg_FM31	System							30.30
M96abl iCu9sti96ti1i o[		] .42	7.4-	80.14	11- .o33°W	3] .0] - °N	127.2]	7.41
M96abl iCu9sti(Extensaun)i96ti1i 0[		3.2]	5.13	80.54	11- .o2] °W	3] .024°N	1-] .12	3.5o
An9c9p98Dl mei96ti1i 4[		10.4]	5.34	80.2]	11- .oo1°W	33.o57°N	1o5.1o	4.- 2
Sama8S9nt9iRus9i 2[		1- .47	5.0o	0.o3	11- .ooo°W	3] .4] 1°N	3] 2.o0	4.2]
O9kiRadgei(Onshure)i 0[		42.17	5.23	0.- 5	11o.142°W	3] .47o°N	344.] 3	1.5-
Sas9ri 1[		1o.oo	5.7-	0.33	11o.07o°W	3] .] 0- °N	3] 3.4-	1.2o
S9niPedruiB9sani 11[		41.4o	7.- 2	1.]]	11- .5o5°W	33.o] 1°N	135.o2	1.40
O9kiRadgei(Onshure)i 3[		4o.5]	5.25	1.0o	11- .o4o°W	3] .374°N	3.72	1.11
UC33brAvg_FM34	System							42.4-
An9c9p98Dl mei96ti4i 2[		10.24	5.42	80.3o	11- .o- o°W	33.o54°N	1o2.51	] .0-
M96abl iCu9sti(Extensaun)i96ti4i 0[		3.71	5.25	80.oo	11- .o2] °W	3] .02] °N	1- 2.15	3.4-
Sama8S9nt9iRus9i 2[		1- .47	5.07	0.o7	11- .ooo°W	3] .4] 1°N	3] 2.o0	4.37
M96abl iCu9sti96ti4i] [		] .45	7.- o	80.25	11- .o33°W	3] .021°N	12] .- 0	1.oo
O9kiRadgei(Onshure)i 0[		42.17	5.] 7	0.o7	11o.142°W	3] .47o°N	344.] 3	1.77
Sas9ri 1[		1o.oo	5.7]	0.3-	11o.07o°W	3] .] 0- °N	3] 3.4-	1.34
UC33brAvg_FM31i(upt)	Grad							44.3-
PuantSul rceFanate:i811- .o21,i3] .143		7.5-	2.73	0.74	11- .o21°W	3] .143°N	0.00	4.oo
PuantSul rceFanate:i811- .o21,i3] .143		7.5-	2.73	0.74	11- .o21°W	3] .143°N	0.00	4.oo
PuantSul rceFanate:i811- .o21,i3] .134		5.3-	2.75	0.50	11- .o21°W	3] .134°N	0.00	4.7o
PuantSul rceFanate:i811- .o21,i3] .134		5.3-	2.75	0.50	11- .o21°W	3] .134°N	0.00	4.7o
PuantSul rceFanate:i811- .o21,i3] .155		11.07	2.5]	1.40	11- .o21°W	3] .155°N	0.00	1.- 5
PuantSul rceFanate:i811- .o21,i3] .155		11.07	2.5]	1.40	11- .o21°W	3] .155°N	0.00	1.- 5
PuantSul rceFanate:i811- .o21,i3] .40]		14.- 5	2.o5	1.42	11- .o21°W	3] .40] °N	0.00	1.4]
PuantSul rceFanate:i811- .o21,i3] .40]		14.- 5	2.o5	1.42	11- .o21°W	3] .40] °N	0.00	1.4]
UC33brAvg_FM34i(upt)	Grad							44.03
PuantSul rceFanate:i811- .o21,i3] .143		7.5-	2.72	0.70	11- .o21°W	3] .143°N	0.00	4.54
PuantSul rceFanate:i811- .o21,i3] .143		7.5-	2.72	0.70	11- .o21°W	3] .143°N	0.00	4.54
PuantSul rceFanate:i811- .o21,i3] .134		5.32	2.50	0.75	11- .o21°W	3] .134°N	0.00	4.71
PuantSul rceFanate:i811- .o21,i3] .134		5.32	2.50	0.75	11- .o21°W	3] .134°N	0.00	4.71
PuantSul rceFanate:i811- .o21,i3] .155		11.43	2.50	1.47	11- .o21°W	3] .155°N	0.00	4.0-
PuantSul rceFanate:i811- .o21,i3] .155		11.43	2.50	1.47	11- .o21°W	3] .155°N	0.00	4.0-
PuantSul rceFanate:i811- .o21,i3] .40]		14.- -	2.o5	1.42	11- .o21°W	3] .40] °N	0.00	1.4]
PuantSul rceFanate:i811- .o21,i3] .40]		14.- -	2.o5	1.42	11- .o21°W	3] .40] °N	0.00	1.4]

SC6164
MP 2.96

ASCE Hazards Report

Address:	**Standard:**	ASCE/SEI 7-16	**Latitude:**	34.086503
No Address at This Location	**Risk Category:**	II	**Longitude:**	-118.950182
	Soil Class:	C - Very Dense Soil and Soft Rock	**Elevation:**	983.2305421851612 ft (NAVD 88)





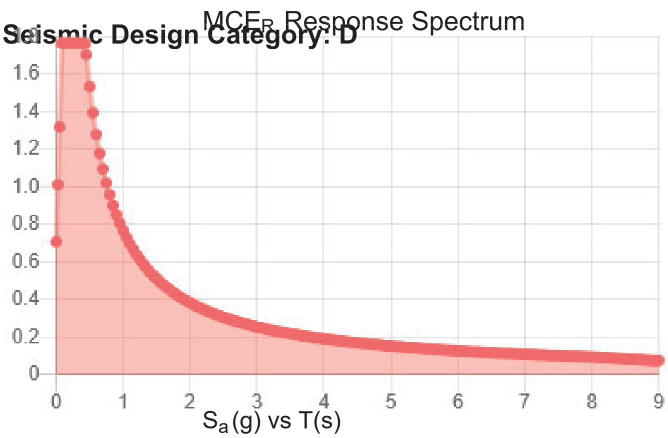
Seismic

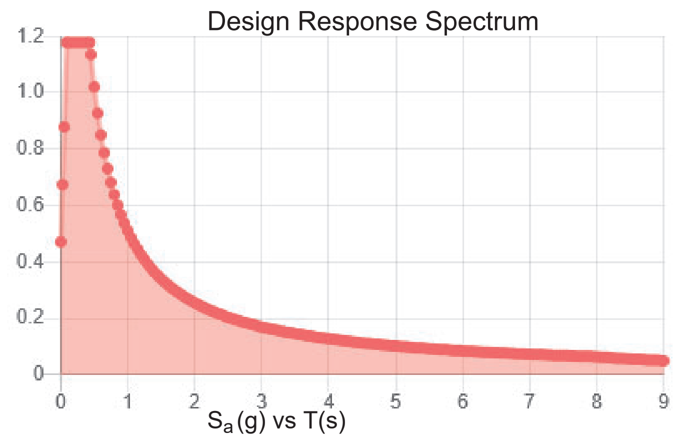
Site Soil Class: C - Very Dense Soil and Soft Rock

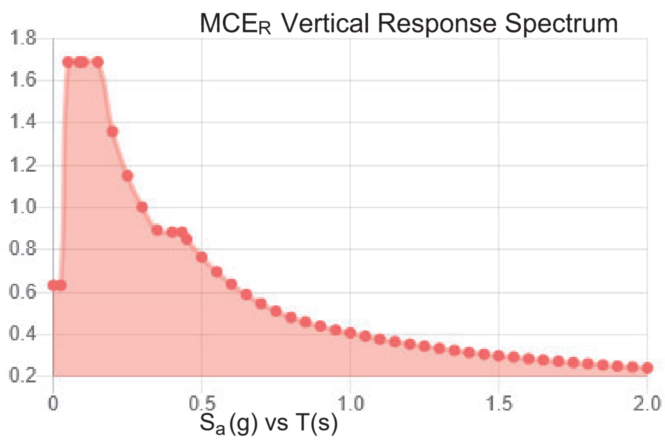
Results:

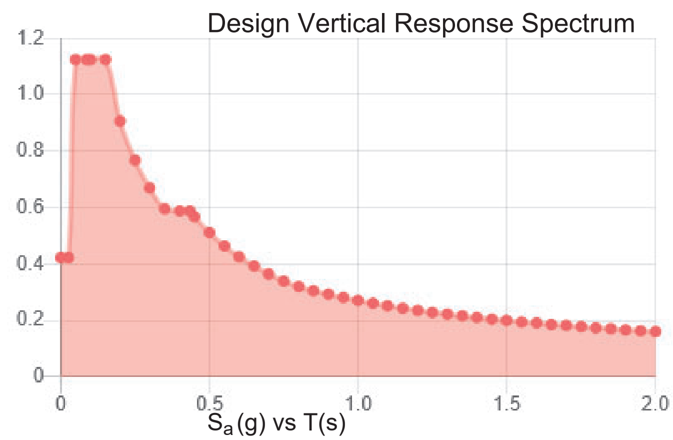
S_S :	1.471	S_{D1} :	0.511
S_1 :	0.516	T_L :	8
F_a :	1.2	PGA :	0.631
F_v :	1.484	PGA_M :	0.758
S_{MS} :	1.765	F_{PGA} :	1.2
S_{M1} :	0.766	I_e :	1
S_{DS} :	1.177	C_v :	1.194

Seismic Design Category: D









SC6164
MP 2.96

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.

Please also see the new USGS Earthquake Hazard Toolbox for access to the most recent NSHMs for the conterminous U.S. and Hawaii.

Input

Edition

Dynamic: Conterminous U.S. 2014 (...

Spectral Period

Peak Ground Acceleration

Latitude

Decimal degrees

34.065803

Time Horizon

Return period in years

478

Longitude

Decimal degrees, negative values for western longitudes

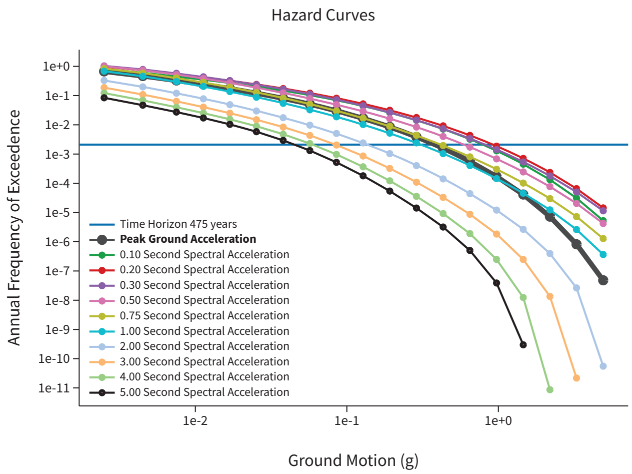
-116.980162

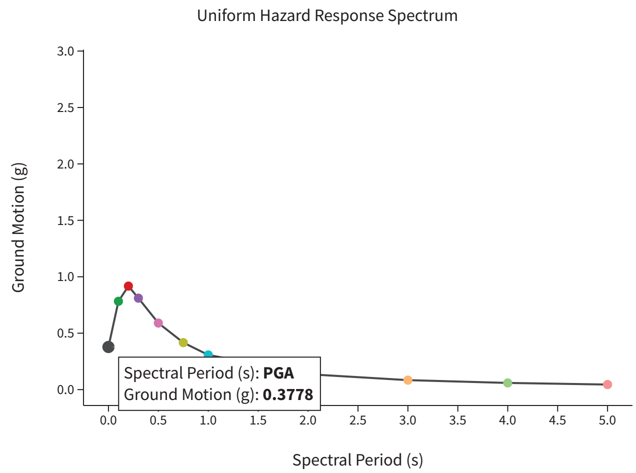
Site Class

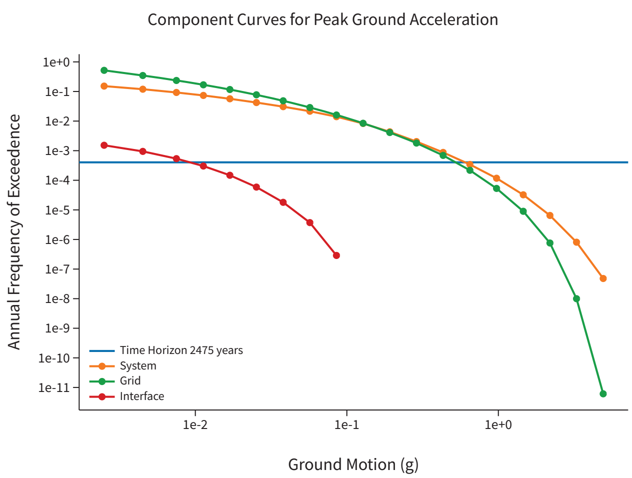
837 m/s (Site class C)

SC6164
MP 2.96

Hazard Curve





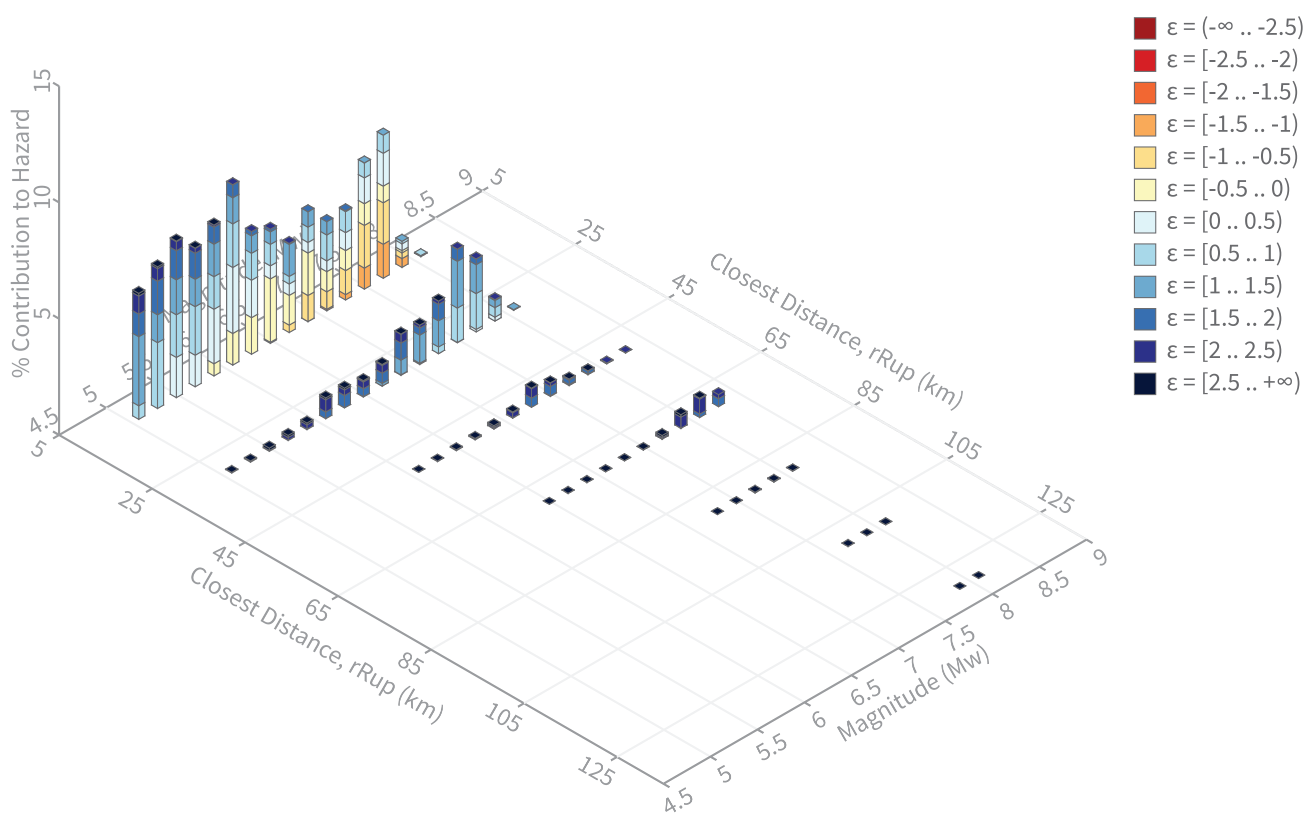


View Raw Data

^ Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 475 yrs
Exceedance rate: 0.0021052632 yr^{-1}
PGA ground motion: 0.377g1279 %

Recovered targets

Return period: 501.g9229 yrs
Exceedance rate: 0.0019924594 yr^{-1}

Totals

Binned: 100 k
Residual: 0 k
Trace: 0.1g k

Mean (over all sources)

m: 6.55
r: 15.33 m8
ε_0: 0.73 σ

Mode (largest m-r bin)

m: 6.11
r: g.4g m8
ε_0: 0.51 σ
Contribution: 7.75 k

Mode (largest m-r-ε_0 bin)

m: 5.09
r: 6.g9 m8
ε_0: 1.2 σ
Contribution: 2.97 k

Discretization

r: 8 in = 0.0, 8 ax = 1000.0, Δ = 20.0 m8
m: 8 in = 4.4, 8 ax = 9.4, Δ = 0.2
ε: 8 in = -3.0, 8 ax = 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							0. 966
Malibu Coast alt 1 [.]		4921	2907	-8986	1179 33°W	349847°N	16. 944	697(
Malibu Coast Exnte) sio) 5alt 1 [8]		39 2	(914	-8922	1179 64°W	349860°N	17492.	392(
A) acapa-Dume alt 1 [0]		18964	(930	-8961	1179 . 1°W	339 (2°N	1. 29 0	0971
Simi-Sa) ta Rosa [6]		1(97(	(98.	89 0	1179 . . °W	349041°N	346932	0928
Oak Ridge EO) shore5[8]		049 8	(963	897(	11. 9106°W	34902. °N	3019(6	19(7
Sisar [1]		1. 970	(927	8930	11. 982. °W	349487°N	3409 .	196.
Sa) Pedro Basi) [11]		01962	2976	1942	1179(. (°W	339 41°N	137974	1910
Oak Ridge EO) shore5[3]		0. 936	(96(	1987	1179 0. °W	349320°N	3967	1911
UC33brAvg_FM30	System							0497(
A) acapa-Dume alt 0 [6]		18970	(906	-8933	1179 . 7°W	339 (4°N	1. . 937	39 0
Malibu Coast Exnte) sio) 5alt 0 [8]		39 .	(96(	-89 2	1179 64°W	349864°N	176923	3906
Simi-Sa) ta Rosa [6]		1(97(	(986	89 6	1179 . . °W	349041°N	346932	0941
Malibu Coast alt 0 [4]		4921	297.	-8964	1179 33°W	349861°N	167981	19 2
Oak Ridge EO) shore5[8]		049 8	(942	89 2	11. 9106°W	34902. °N	3019(6	1922
Sisar [1]		1. 970	(924	893(	11. 982. °W	349487°N	3409 .	1930
UC33brAvg_FM31 Eopt5	Grid							03988
Poi) tSourceFi) ite: -1179 68, 34910(		29((	6924	8923	1179 68°W	34910(°N	8988	2986
Poi) tSourceFi) ite: -1179 68, 34910(		29((	6924	8923	1179 68°W	34910(°N	8988	2986
Poi) tSourceFi) ite: -1179 68, 349171		11986	69(4	1901	1179 68°W	349171°N	8988	1973
Poi) tSourceFi) ite: -1179 68, 349171		11986	69(4	1901	1179 68°W	349171°N	8988	1973
Poi) tSourceFi) ite: -1179 68, 349087		10972	69 (	1902	1179 68°W	349087°N	8988	19(4
Poi) tSourceFi) ite: -1179 68, 349087		10972	69 (	1902	1179 68°W	349087°N	8988	19(4
UC33brAvg_FM30 Eopt5	Grid							0096.
Poi) tSourceFi) ite: -1179 68, 34910(		29(2	6922	8928	1179 68°W	34910(°N	8988	6927
Poi) tSourceFi) ite: -1179 68, 34910(		29(2	6922	8928	1179 68°W	34910(°N	8988	6927
Poi) tSourceFi) ite: -1179 68, 349171		11903	69(8	190(	1179 68°W	349171°N	8988	0983
Poi) tSourceFi) ite: -1179 68, 349171		11903	69(8	190(	1179 68°W	349171°N	8988	0983
Poi) tSourceFi) ite: -1179 68, 349087		10976	69 7	1902	1179 68°W	349087°N	8988	19(3
Poi) tSourceFi) ite: -1179 68, 349087		10976	69 7	1902	1179 68°W	349087°N	8988	19(3