ATTACHMENT 1C
GEOTECHNICAL REPORT

GEOTECHNICAL REPORT
PROPOSED SANDIA CREEK DRIVE BRIDGE REPLACEMENT PROJECT
SAN DIEGO COUNTY, CALIFORNIA

Prepared for:

KPFF

400 Oceangate, Suite 500
Long Beach, California 90802

Project No. 12115.001

December 13, 2019

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

December 13, 2019

Project No. 12115.001

KPFF
400 Oceangate, Suite 500
Long Beach, California 90802

Attention: Mr. Jose Hernandez

Subject: Geotechnical Report
Proposed Sandia Creek Drive Bridge Replacement Project
San Diego County, California

Leighton Consulting, Inc. (Leighton) is pleased to submit this report presenting the results of our geotechnical exploration for the proposed Sandia Creek Drive Bridge Replacement Project over the Santa Margarita River (project site) in San Diego County, California. The purpose of this exploration was to evaluate the geologic and geotechnical conditions at the project site, and to provide recommendations for design and construction of the project.

We appreciate the opportunity to be of service to you on this project. If you have any questions or if we can be of further assistance, please call us at your convenience.

Respectfully submitted,

LEIGHTON CONSULTING, INC.

REGISTERED PROFESSIONAL ENGINEER
VINCENT PING-KUEN IP
No. 2522
Exp. 3/2020
GEOTECHNICAL
STATE OF CALIFORNIA

CERTIFIED ENGINEERING GEOLOGIST
JEFFREY M. PFLUEGER
No. 2499
STATE OF CALIFORNIA

Vincent P. Ip, PE, GE 2522
Senior Principal Engineer

Jeffrey M. Pflueger, PG, CEG 2499
Associate Geologist

JMP/VPI/lr

Distribution: (1) Addressee

17781 Cowan ▪ Irvine, CA 92614-6009
949.250.1421 ▪ 949.250.1114 Fax

TABLE OF CONTENTS

Leighton

TABLE OF CONTENTS (CONTINUED)

Section Page

Tables

ATTACHMENTS

Figures

Appendices

Plates

1.0 INTRODUCTION

1.1 Site Location and Description

Sandia Creek Drive currently crosses the west flowing Santa Margarita River approximately 2 miles to the north of Downtown Fallbrook between the Santa Margarita River Hiking Trail and the intersection between Sandia Creek Drive and Rock Mountain Drive.

The terrain within the floodplain area of the San Margarita River is gently sloping with elevations that range between approximately +330 and +345 feet above mean sea level (msl) near the proposed bridge alignment. The actively flowing portion of the river is located in the southwestern portion of the proposed bridge alignment. The proposed bridge alignment is a continuation of the existing Sandia Creek Drive over the Santa Margarita River approximately 160 feet to the northwest of the existing river crossing (See Figure 1, *Site Location Map*).

1.2 Proposed Bridge Structure

The new Sandia Creek Drive bridge, spanning approximately 570 feet between abutments will feature one (1) lane of traffic in each direction with four (4) spans supported on three (3) row of piers and two (2) abutments. The existing ground elevation at the proposed southwestern abutment (Abutment 1) of the bridge is at approximately +348 feet and the existing ground elevation at the proposed northeastern abutment (Abutment 5) of the bridge is at approximately +344 feet. The existing ground elevation at the proposed pier 2, 3, and 4, are at approximately +336, +335, +338 feet, respectively. The northern abutment will consist of a (MSE) to support the approach at the end of the bridge.

The current foundation scheme for supporting the bridge structure consists of two (2) 48-inch diameter cast-in drilled-hole (CIDH) piles at each support location.

Caltrans Pre-Designed mechanically stabilized embankment (MSE) wall with height up to approximately 12 feet and length of approximately 25 feet is proposed at the northern bridge abutment. The south abutment will consist of wing walls cantilevering on the foundation to support the approach fill.

1.3 Design Standards

For the purpose of this project, our geotechnical exploration and design recommendations will conform to the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Bridge Design Specifications 6th edition of the California Amendment and other Caltrans documents related to bridge design (See Appendix A, *References*).

1.4 Purpose and Scope of Work

The purpose of our field exploration was to evaluate the subsurface conditions at the project site and to develop foundation recommendations and geotechnical design parameters for the planned bridge.

Our scope of work included the following tasks:

- *Literature Review*: We reviewed various documents pertinent to the project site including previous geotechnical reports and others (See Appendix A, *References*).
- *Permits:* It was our understanding that site entry permission from the Wildlands Conservancy and appropriate permitting from the California Department of Fish and Wildlife (CDFW) for Leighton's personnel and exploration subcontractors was obtained by Trout Unlimited prior to field activities. In addition, Trout Unlimited obtained a permit from the San Diego County Department of Environmental Health for the excavation of the borings.
- *Field Exploration*: Cascade Drilling was retained by Trout Unlimited to advance three (3) borings along the proposed bridge alignment. The borings were logged in the field by a California Certified Engineering Geologist from our firm.
- *Geotechnical Laboratory Testing:* We conducted geotechnical laboratory testing of representative soil and bedrock samples obtained during the field exploration for soil classification and to evaluate engineering properties of the earth materials encountered.
- *Geotechnical and Seismic Analyses and Design*: We performed geotechnical and seismic analyses using the collected data to develop geotechnical design recommendations for foundations and construction of the proposed bridge.

- *Report Preparation*: We prepared this report presenting our geotechnical findings, conclusions and recommendations for the proposed project.

1.5 Previous Study

A *Preliminary Foundation Report (Draft)* for the project was prepared by Diaz Yourman & Associates (DYA, 2018) to evaluate three bridge location options for the new bridge that were being considered. As a part of their study, a geophysical survey and geologic reconnaissance were performed at the site. The geophysical survey was performed at the site by Southwest Geophysics, Inc. (SGI, 2018) to aid in evaluating the subsurface velocity profiles along the proposed bridge alignments. Six (6) P-wave refraction traverses and five (5) refraction microtremor (ReMi) profiles were conducted at the site on February 5, 2018. A copy of SGI's report with the results of the geophysical surveys is included in Appendix B. The approximate locations of the P-wave refraction traverses (SL-1 and SL-2) and the microtremor (ReMi) profile (RL-1) that are within the currently proposed bridge alignment are shown on Plate 1, *Exploration Location Map.*

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

Prior to performing the field exploration, Trout Unlimited performed a site reconnaissance to locate the proposed boring locations and evaluate the access for drilling equipment for the proposed borings. Trout Unlimited coordinated approval for performing the field exploration and established a drill rig access path by clearing the existing vegetation for access to the proposed boring locations.

2.1.1 Subsurface Exploration

Between February 18 and 20, 2019, on February 22 and 23, 2019, and on March 14 and 15, 2019, Leighton performed a geotechnical subsurface exploration at the project site to develop geotechnical recommendations. During the exploration, a total of three (3) borings (LB-1 through LB-3) were excavated at the locations of the proposed foundations as shown on Plate 1, *Exploration Location Map*. The borings were advanced to depths ranging between approximately 42.5 and 70 feet below existing ground surface (bgs) using both mud rotary and HQ3 continuous rock core drilling techniques. In general, mud rotary drilling and drive sampling was conducted until bedrock was reached. Once bedrock was reached, HQ3 continuous rock core drilling was performed to the total depth. Drilling at LB-1 was terminated at approximately 42.5 feet bgs when the drilling difficulty and rate of advancement became extremely inefficient. The maximum drilling depth was 70 feet at boring LB-2 with approximately 49 feet penetration into the bedrock. It should be noted that HQ3 continuous rock core drilling was performed from the ground surface to total depth in boring LB-3 due to a large cobble or boulder immediately below the ground surface that was causing drilling difficulty and jeopardizing the integrity of the seal for the drilling fluid.

The drilling activities were supervised and the subsurface conditions were logged during drilling by a California Certified Engineering Geologist from Leighton. The boring locations and profiles are shown on Plate 2, *Log of Test Borings*.

Borings LB-1 and LB-2 were performed using a limited access track-mounted drilling rig and boring LB-3 was performed using a truck mounted CME-85 drilling rig. A Standard Penetration Test (SPT) sampler was mechanically driven in the upper alluvial soils in borings LB-1 and LB-2 to collect samples for geotechnical laboratory testing and analyses.

2.2 Geotechnical Laboratory Testing

The engineering properties of the site soil and bedrock materials were evaluated by testing representative samples obtained during drilling by the following test methods:

- In-situ moisture content and dry density (ASTM D2216 and ASTM D2937);
- Unconfined compressive strength (ASTM D 2166); and
- Corrosion, including water-soluble sulfate (CTM Test 417), water-soluble chloride (CTM Test 422), pH and minimum resistivity (CTM Test 532/643).

The results of the laboratory tests are presented in Appendix C, *Laboratory Test Results*.

3.0 GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Site Geology

The project site is located to the south of the Santa Rosa Plateau and southwest of the fault controlled Elsinore-Temecula trough within the Peninsular Ranges geomorphic province of California. This area is in the western zone of the southern California batholith that has experienced regional tectonic uplift, weathering and erosion that has created the valleys and ridges if the area. The west flowing Santa Margarita River flows through Temecula Canyon from Temecula Valley towards Oceanside where it empties into the Pacific Ocean. In the vicinity of the project site, the Santa Margarita River has carved its path through Cretaceous-age tonalite and granodiorite bedrock and deposited young (late Holocene-age) and older (Pleistocene age) alluvial flood plain deposits as shown on Figure 2, *Geologic Map* (Tan and Kennedy, 2000).

3.2 Subsurface Soil and Bedrock Conditions

Based on our subsurface explorations, the site is underlain by artificial fill, active and older alluvial flood plain deposits and tonalite bedrock. Artificial fill extending approximately 5 feet below the existing ground surface (bgs) associated with establishing a drill rig access path by was encountered at boring LB-1.

The young alluvial soils (map unit: Qa) encountered in the borings within the active river channel consist predominantly of silty sand and sand with localized zones of abundant cobbles and possible boulders. Based on limited blowcounts obtained during drilling, the density of the alluvium was primarily loose. Although not encountered in our borings, older alluvium (map unit: Qoa) is mapped in the vicinity of the proposed southwestern abutment where the existing topography rises out of the active Santa Margarita River Channel as shown on Figure 2, *Geologic Map*. These older alluvial sediments consist of moderately to well consolidated and poorly sorted flood plain deposits (Tan and Kennedy, 2000) expected to consist of variable accumulations of silt, sand, gravel, cobbles and possible boulders.

Tonalite bedrock (map unit: Kt) was encountered beneath the alluvial soils at approximately 13.5 feet bgs in boring LB-1 at the northeastern abutment (elevation +327.0 feet), at approximately 21 feet bgs in boring LB-2 near the center pier location (elevation +318.0 feet), and at approximately 17.5 feet bgs in boring LB-3 at the southwestern abutment (elevation +314.2 feet). The bedrock underlying the alluvium consisted severely to very severely weathered and intensely fractured, olive to blue gray hornblende-biotite tonalite. The rock quality designation (RQD) of the bedrock is generally poor (between 0 and 25) except in boring LB-3 where the RQD ranged from 40 to 80 below a depth of 20 feet bgs. The unconfined compression test results of the selected bedrock core samples are as follows:

Table 1 - Unconfined Compression Test Results

Boring ID	Sample Depth (feet)	Unconfined Compression (psi)	Elastic Modulus (psi)
LB-1	38.2 to 38.7	23,255	6,760,000
LB-2	66.6 to 63.4	1,870	372,500
LB-3	31 to 31.5	11,919	1,265,823

According to Cooper Testing Laboratory, the LB-2 sample failed along per-existing healed fractures. Detailed descriptions of the soil and bedrock materials encountered in the borings are presented on Plate 2, *Log of Test Borings*.

The shear wave velocity within the top 100 feet of the site (i.e. V_{S30}) was estimated at the two abutment areas and near the center pier location based on review of the geophysical survey performed at the site by Southwest Geophysics, Inc. (SGI, 2018). Based on result of the P-wave refraction traverses and refraction microtremor (ReMi) profile that were conducted at the site, the depth-weighted V_{S30} is approximately 750 meter per second.

A copy of SGI's report with the results of the geophysical surveys is included in Appendix B.

3.3 Groundwater Conditions

Groundwater was not directly measured in the borings due to the method of drilling, i.e. mud rotary. However, due to the proximity of the active Santa Margarita River Channel, groundwater is expected at the approximate river flowline elevation of +327 feet due to the granular nature of the alluvial soils in the river channel.

The groundwater depth will depend on the water level in the Santa Margarita River. Fluctuations of the groundwater level, should be anticipated during and following precipitation that typically occurs during the winter season and/or periods of locally intense rainfall or storm water runoff.

3.4 Idealized Soil Profile

Based on the results of field exploration and laboratory testing, the subsurface soil at the site may be represented by an idealized soil profile as follows:

Table 2 - Idealized Soil Profile

Support Location	Approximately Elevation (feet)	Predominant Soil Type (USCS)	SPT Blowcount $(N1)_{60}$	Friction Angle (degree)	Shear Strength (ksf)
Abutment 1	+347 to +342	SM, SP, and SW	12	33	
	+342 to +334	SP	N/A	36	
	+334 to +324	Weather Bedrock			134
	Below +324	Bedrock			850
Pier 2	+336 to +314	SM, SP, and SW	12	33	
	+314 to +304	Weather Bedrock			134
	Below +304	Bedrock			850
Pier 3	+335 to +320	SM, SP, and SW	12	33	
	+320 to +310	Weather Bedrock			134
	Below +310	Bedrock			850
Pier 4	+338 to +325	SM, SP, and SW	12	33	
	+325 to +315	Weather Bedrock			134
	Below +315	Bedrock			850
Abutment 5	+344 to +329	SM, SP, and SW	12	33	
	+329 to +319	Weather Bedrock			134
	Below +319	Bedrock			850

Groundwater is assumed at elevation +327 feet.

3.5 Scour Potential

The design scour depth for evaluating the bridge foundation were provided River Focus Inc. The scour data was for the previous existing bridge layout. Based on proximity and geologic conditions of the site we have adjusted those to the new bridge support locations.

Table 3 - Scour Data

Support Location	Scour Depth (feet)		
	Contraction Scour	Long-term Scour	Local Scour
Abutment 1	0	0	6.6
Piers 2 & 3			19.7
Pier 4			14.7

4.0 SEISMIC HAZARDS

The site is located in a seismically active region of southern California with several major active and potentially active faults within the region that are capable of generating earthquakes with a Magnitude of 7.0 and larger. The following sections discuss the major faults in the vicinity of the project site and the potential seismic hazards associated with strong earthquakes resulting from these faults and other major faults in the region.

4.1 Surface Fault Rupture Potential

Our review of available in-house literature indicates that no known active faults have been mapped traversing the project site, and the site is not located within a California designated Alquist-Priolo Earthquake Fault Zone (CGS, 1990; Bryant and Hart, 2007). Therefore, a surface fault rupture hazard evaluation is not mandated for this site and the potential for surface fault rupture at the site is considered to be low. In addition, per Caltrans Memo to Designer 20-10 (Caltrans, 2013), further fault study is not required since the site is not located within an AP zone or within 1,000 feet of an unzoned fault that is Holocene or younger in age.

4.2 Seismicity and Ground Motions

The site is expected to experience moderate to strong earthquake ground motions during its life span. The magnitude of ground motion is generally characterized by using the peak horizontal ground acceleration (PHGA). Based on the fault database in the Caltrans ARS Online (v2.3.09) web tool (http://dap3.dot.ca.gov/ARS_Online/), the three principal earthquake faults in the area and the deterministic seismic parameters of these faults are summarized in the table below:

Table 4 – Fault Characteristics

Fault ID/Name	Type of Slip	Maximum Magnitude	Distance From Site (km)	Estimated PHGA (g)
378/Elsinore (Temecula)	Strike Slip	7.7	13.05	0.26
365/Elsinore (Glen Ivy)	Strike Slip	7.7	23.39	0.17
390/Elsinore (Julian)	Strike Slip	7.7	23.50	0.17
The estimated PHGA was based on the average of the Cambell-Bozorgnia (2008) and Chiou-Youngs (2008) ground motion attenuation models.				

Using the ARS web tool, the probabilistic and deterministic ARS curves were developed for each abutment using the respective V_{S30} (See Section 3.2). Based on analysis and by comparing the probabilistic and deterministic ARS curves at each abutment, the probabilistic ARS curves will be the governing design ground motion. The design ARS curve with adjustments for near fault and basin effects is presented in Appendix D, *Seismic Hazard Analysis.* Development of vertical response spectral is excluded from the current scope.

Based on the enveloped ARS curve, the PHGA at the site is approximately 0.35g. By deaggregating the PHGA with respect to magnitude and distance, the modal earthquake for the site is a magnitude 6.7 event at a distance of 10 miles from the site.

4.3 Liquefaction Potential and Associated Hazard Evaluation

Soil liquefaction is a general term in reference to reduction of strength and stiffness in soils due to build-up of pore water pressure during strong ground shaking. Common hazards associated with soil liquefaction are reduction in bearing support of foundations, ground settlement and downdrag load on piles, slope instability (flow failure), and lateral spread in gently sloping ground.

Liquefaction Potential: The project site is located in an area that has not been evaluated by the California Geological Survey (CGS) for liquefaction hazard potential. The younger alluvial soils along the proposed bridge alignment generally consist of loose silty sand and sand with localized zones of abundant cobbles and possible boulders overlying bedrock. Liquefaction potential for the onsite alluvium was evaluated using the SPT method from NCEER Workshops (Youd and Idriss, 2001). Results of our analysis indicated that the younger alluvial soils are susceptible to liquefaction during strong ground shaking. Based on the limited subsurface investigation, the areas susceptible to liquefaction span approximately from Piers 2 to 4. Due to the shallow bedrock depths at the abutments, liquefaction potential is not a concern. The older alluvium above the bedrock is not susceptible liquefaction.

Reduction in Bearing Support: Due to soil liquefaction, the younger alluvial soil will lose most of its capacity to support foundations and ground improvements will be used to reduce the impact of liquefaction (See Sections 5.3 and 5.4). We do not anticipate the older alluvium and the bedrock will experience loss of shear strength during strong ground shaking.

Ground Settlement: Ground settlement due to liquefaction was evaluated in conjunction with liquefaction analysis. The calculated maximum ground settlement due to liquefaction was approximately 3 inches between Piers 3 and 4. The results of our liquefaction analysis are included in Appendix E, *Liquefaction Analysis*.

Lateral Spread: Evaluation of the lateral spread was performed for each support location using the Newmark sliding block model under pseudo-static loading condition. The calculations were performed using computer program SLIDE (Rocscience 2018). The estimated lateral spread displacements are summarized as follows:

Table 5 - Summary of Lateral Spread Displacement

Support Location	Critical Acceleration (g)	Displacement (inches)
Pier 2	0.015	45
Pier 3	0.043	18
Pier 4	0.115	3

The calculations are also included in Appendix E, *Liquefaction Analysis*.

Ground improvement is planned to reduce the adverse effects of liquefaction at Piers 2 and 3. Discussion of ground improvements for the two piers are presented in Section 5.4. Based on discussion with the structural engineer, the lateral displacements at Pier 4 is within tolerable pile displacements. Therefore, no ground improvement is required.

4.4 Earthquake-Induced Landslides

The project site and its vicinity are located in an area that has not been evaluated by the California Geological Survey (CGS) for seismically-induced landslide hazard potential. Because the slopes will be replaced by MSE, the potential for slope instability to occur in these areas is considered negligible. The stability of the MSE will be addressed as part of the bridge approach embankment in Section 5.2.

4.5 Seiches and Tsunamis

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the absence of enclosed bodies of water near the site and the inland location of the site, seiches and tsunami risks at the site are considered negligible.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our exploration, we conclude that the proposed Sandia Creek Drive Bridge Replacement Project is feasible from a geotechnical standpoint. The following sections provide preliminary recommendations to aid in the design and construction of the proposed bridge improvements. Final recommendations will be submitted in the final Geotechnical Design Report and Foundation Design Report.

5.1 Earthwork and Grading

Earthwork construction should be performed in accordance with Caltrans Standard Specifications, Chapter 4 Section 19 (Caltrans, 4-19). Design and construction of shoring and temporary excavation is the responsibility of the contractor and should conform to all State and local safety requirements. The geotechnical engineer should review the shoring plans prior to implementation.

5.2 Bridge Approaches Embankments

Earth Pressure: The lateral earth pressure parameters for designing abutment walls are as follow:

Table 6 - Earth Pressure Design Parameters for Abutment Walls

Condition	Level Backfill	2:1 Back Slope
Active (K_a)	0.28	0.44
At-Rest (K_0)	0.44	0.68
Seismic Increment (unrestrained)	0.15	0.25
Seismic Increment (Restrained)	0.24	0.35
Level Passive (K_p)	3.25	
Coefficient of Friction	0.35	

If applicable, a uniform pressure of 72 pounds per square foot (psf) due to vehicle surcharge should be added to the lateral earth pressure. A moist unit weight of 120 pounds per cubic foot is recommended for calculating the earth pressure.

The recommendations are for granular soil backfill with a proper wall drainage system to prevent hydrostatic pressure build-up behind the wall. When the wall is free to move (unrestrained) at the top, the wall may be designed using active pressure. When the wall is restricted from movements at the top, at rest pressure should be used for designing the walls.

The seismic earth pressure increments were calculated based on the study by Agusti and Sitar (Agusti and Sitar, 2013) using a free field ground acceleration of 0.35g. The point of application of the resultant load may be assumed at one-third of the wall height.

5.2.1 Mechanically Stabilized Embankment (MSE)

MSE: Caltrans standard MSE (Caltrans Bridge Design Aid 3-8, 2013) are planned for the bridge approach embankment. The design height of the MSE is on an order of 12 feet for the northeast abutment. The bearing resistance pressure developed at the MSE foundation are summarized below:

Table 7 - Bearing Pressure for Caltrans Standard MSE

Support Location	Wall Height (feet)	Service Limit State	Strength Limit State Φ_b=0.55	Extreme Event Limit State φ_b=1
		Net Contact Stress (ksf)	Factored Gross Nominal Bearing Resistance (ksf)	Factored Gross Nominal Bearing Resistance (ksf)
Abutment 5	12	10.5	5.8	8.5

Settlement: The MSE will be founded on the native alluvium. The estimated static settlement of the alluvium under the MSE is on an order of 1 inch. Most of the settlement is expected to occur during or shortly after construction. The seismically-induced settlement under the MSE at Abutment 5 is expected to be negligible due to shallow bedrock.

Slope Stability: The project site contains slopes along the northeastern bank of the Santa Margarita River on the order of approximately 10 feet in height in the area of the proposed bridge approach. Because the slopes will be replaced by MSE, the potential for slope instability to occur in these areas is considered negligible.

5.3 Foundation Recommendations

The design for axial loading of CIDH piles followed the steps outlined in the Federal Highway Administration (FHWA) National Highway Institute (NHI) Publication No. FHWA-NHI-10-016, *Drilled Shafts: Construction Procedures and LRFD Design Methods* (FHWA-NHI, 2010). Design parameters of the soil conditions for the 48-inch diameter CIDH piles are provided in the table below.

Since ground improvement is planned for the project, capacity analysis for the CIDH piles was conducted with assumed improved ground parameters at the pier locations. Verification of the improved ground parameters used should be checked after ground improvement has been completed.

Due to the poor Rock Quality Designation (RQD) of the fractured bedrock, the regions with fractured bedrock were modeled as sand to characterize its behavior. Since the piles are expected to be tipped in competent bedrock with strength stronger than concrete, end bearing capacity of rock sockets were limited to the strength of the concrete.

Locations	Elevations	Groundwater Elevations	Geologic Units(1)	Soil Type (2)	Total Unit Weight (pcf)	Blow Counts(3) $(N1)_{60}$	Friction Angle(4) (degree)	Intact Rock Modulus (psi)	Coefficient of Subgrade Reaction (lb/in^3) Sand
Abutment 1	347 – 342	327	Qal	Sand	120	12	33		125
	342 – 334		Qoa	Sand	120		36		150
	334 – 324		Kt	Sand	135		33		100
	< 324			Bedrock	150			1.25E6	
Pier 2	336 – 327		Qal	Sand	120	12	35		150
	327 – 315		Qal	Liq. Sand	120	12	35		150
	315 – 305		Kt	Sand	135		33		100
	< 305			Bedrock	150			1.25E6	
Pier 3	336 – 327		Qal	Sand	120	12	35		150
	327 – 320		Qal	Liq. Sand	120	12	35		150
	320 – 310		Kt	Sand	135		33		100
	< 310			Bedrock	150			1.25E6	
Pier 4	338 – 326		Qal	Sand	120	12	33		125
	326 – 324		Qal	Liq. Sand	120	12	33		100
	324 – 314	327	Kt	Sand	135		33		100
	< 314			Bedrock	150			1.25E6	

Locations	Elevations	Groundwater Elevations	Geologic Units(1)	Soil Type (2)	Total Unit Weight (pcf)	Blow Counts(3) $(N1)_{60}$	Friction Angle(4) (degree)	Intact Rock Modulus (psi)	Coefficient of Subgrade Reaction (lb/in³)
									Sand
Abutment 5	344 – 329		Qal	Sand	120	12	33		125
	329 – 319		Kt	Sand	135		33		100
	< 319			Bedrock	150			1.25E6	

Notes:

1. Geologic Units
   Qal: Young Alluvium
   Qoa: Older Alluvium
   Kt: Tonalite Bedrock
2. The following are recommended LPILE default p-y curves for the above idealized soil types:

Predominant Soil Types	LPILE Default p-y Curve Model
Sand	(Reese) should be used for non-seismic loading.
Liquefiable (Liq.) Sand	Hybrid Model for Liquefied Sand (Option 1 in LPILE) should be used for Extreme I Limit State. Reese Model should be used for non-seismic loading.
Bedrock	Massive Rock should be used. Parameters should be taken from the LPILE technical manual in accordance with rock quality.

3. Based on correlation of (N1)60 blowcounts with friction angle (Caltrans Geotechnical Manual, 2014)
4. Friction angle of improved soil was assumed at 35 degrees for the liquefiable soils on Piers 2 and 3.

Leighton

Support Location	Pile Type	Cut-off Elevation (ft)	Service-I Limit State Load per Support[2] (kips)		Total Permissible Support Settlement (inches)	Factored Design Loads (kips)						Design Pile Length (from Cut-off Elevation) (ft)	Design Tip Elevations[1] (ft)	Specified Tip Elevations[3] (ft)
			Total	Permanent		Strength Limit State / Construction			Extreme Event-I State					
						Comp. (φ_{qs} = 0.7)		Tension (φ_{qs} = 0.7)	Comp. (φ_{qs} = 1.0)		Tension (φ_{qs} = 1.0)			
						Per Sup-port	Max Per Pile		Per Sup-port	Max Per Pile				
Abutment 1		341.92	1200	800	1.0	1600	N/A	N/A	1500	N/A	N/A	19.92 (a-I) 17.92 (a-II) 17.92 (c)	322 (a-I) 324 (a-II) 324 (c)	322
Pier 2		342.30	1400	1100	1.0	N/A	2400		N/A	1700		38.3 (a-I) 38.3 (a-II) 38.3 (c)	304 (a-I) 304 (a-II) 304 (c)	304
Pier 3	48” Dia. CIDH Pile	342.30	1400	1100	1.0	N/A	2400	0	N/A	1700	0	32.3 (a-I) 32.3 (a-II) 32.3 (c)	310 (a-I) 310 (a-II) 310 (c)	310
Pier 4		343.36	1500	1200	1.0	N/A	2400		N/A	1700		28.36 (a-I) 28.36 (a-II) 28.36 (c)	315 (a-I) 315 (a-II) 315 (c)	315
Abutment 5		341.60	1200	800	1.0	2000	N/A	N/A	1500	N/A	N/A	21.6 (a-I) 21.6 (a-II) 21.6 (c)	320 (a-I) 320 (a-II) 320 (c)	320

Notes:

1. Design tip elevations are controlled by: (a-I) Compression (Strength Limit), (b-I) Tension (Strength Limit), (a-II) Compression (Extreme Event-I), (b-II) Tension (Extreme Event-I), (c) Settlement.
2. For Service Limit State per Support = Abutment 1 & Abutment 5 total load at pier
   Pier 2,3, & 4 load at each pile
3. The specified tip elevation shall not be raised without approval from the Engineer.

5.3.1

5.3.1 Lateral Pile Capacity

The analysis of the CIDH piles subject to lateral load is being performed by KPFF using the soil parameters presented in the Idealized Soil Profile Table. In addition, p-multipliers based on Table 10.7.2.4-1 of the ASSHTO Bridge Design Specifications (2012) should be incorporated in the analysis of the piles subject to longitudinal and traverse lateral.

5.4 Ground Improvement

Ground improvement is proposed at Piers 2 and 3 to reduce the adverse effects of lateral spread due to liquefaction. The primary purpose of the ground improvement is stabilize the liquefiable soils around piles. The soils beyond the improved zone could experience movements in the form of settlement or slumping should liquefaction occur.

The mitigation of the liquefaction potential consists of in-situ improvement of the soils via the technique of vibro-replacement (“Stone columns”) or Rammed Aggregate Piers (RAPs) is recommended for the project at this time. The minimum extent of the ground improvement should extend at least 20 feet longitudinally on both sides from edge of pile and 20 feet transversely on both sides from edge of pile caps. The anticipated depth of mitigation are as follows:

Support Location	Minimum Mitigation Elevation (feet)
Pier 2	305
Pier 4	310

The scour protection plan is only planned for the immediate vicinity of the piers. Based on the scour protection scheme, the depth of the ground improvement zone may be assumed to start at the bottom of the scour depth.

As an alternative, permeation grouting may be considered if installation of stone columns or RAPs is found to be difficult due to presence of cobbles.

5.5 Corrosion Evaluation

As a screening for potentially corrosive soil, a representative soil sample was tested to assess minimum resistivity, chloride content, and pH. The test results are included in Appendix D of this report and are summarized in the following table.

Table 8 – Soil Corrosion Potential

Test	Results	Corrosivity Threshold[1]	General Classification of Hazard
Water-Soluble Sulfate (ppm)[2]	55-123	> 2,000 ppm	Low Sulfate Exposure on Concrete
Water-Soluble Chloride (ppm)	50-61	> 500 ppm	Low Chloride Exposure on Concrete
pH	8.11 – 8.20	≤ 5.5	Slightly Alkaline Soil
Minimum Resistivity (oh-cm)	3220-6960	≤ 1000	Non-corrosive to buried metals

Notes:

1. Threshold values are per Caltrans Standard.
2. ppm: Parts per million.

5.6 Pavements

5.6.1 Hot Mixed Asphalt (HMA) Concrete Pavement

Assuming an R-value of 40 for the MSE backfill materials (source not yet identified) and a design R-value of 78 for the aggregate base course, the recommended HMA pavement sections for all traffic lanes based on Chapter 630 of the California Highway Design Manual (Caltrans 2017) are as follows.

Table 9 – Recommended HMA Pavement Section

Segment	Traffic Index	Pavement Thickness (feet)	
		HMA	Aggregate Base (AB)
All Lanes	7.5	0.42	0.67
	9.0	0.58	0.75

The HMA should conform to Open Grade PG 64-10. All pavement materials and construction should conform to the Section 39 Asphalt Concrete Caltrans Standard Specifications *(Caltrans 2018)*.

5.6.2 Joined Plain Concrete Pavement (JPCP) Pavements

Based on the design R-value of 40, the subgrade soil is classified as Type II Subgrade in the Low Mountain/South Mountain Region based on Chapter 620 Rigid Pavement of the Caltrans Highway Design Manual (Caltrans 2017). The recommended JPCP section is as follows:

Table 10 – Recommended JPCP Pavement Section

Segment	Traffic Index	Pavement Thickness (feet)	
		PCC	AB
All Lanes	7.5 to 9	0.75	1.0[(1)]

Construction of concrete pavement should follow Section 40 Concrete Pavement of the Caltrans Standard Specifications (*Caltrans 2018*).

5.7 Construction Considerations

Earthwork Construction: Earthwork Construction should follow Caltrans Standard Specifications, Section 19 (Caltrans 2015). Open excavation is expected for the construction of the abutments. The contractor should be responsible for excavation safety. Shoring, if required should be designed by a Registered Civil Engineer and the plans should be review by the Geotechnical Engineer prior to implementation. Heavy equipment and or stockpile should not be operated or placed immediately adjacent to open or shored excavation unless surcharge pressure from the equipment has been properly accounted for. The contractor should be responsible for controlling surface water and groundwater to accommodate construction. Water should be removed from excavation to allow a dry bottom suitable for placing and compacting soil fill.

Ground Improvements: Ground improvement technique should be designed and performed by a specialty contractor. Field observation of ground improvement should be provided by the Geotechnical Engineer. Upon completion of the ground improvement process, a field verification program is recommended to verify adequate improvement of the soils. A minimum friction angle of the improved soils should be 35 degree.

CIDH Pile Installation: The bridge piers will be supported by 4-foot diameter CIDH piles. The contractor should follow requirements of Caltrans Standard Specifications Section 49 (Caltrans 2015) for “wet” CIDH pile construction. In addition, Gamma-Gamma testing per CT 233 should be performed to verify the pile integrity.

6.0 LIMITATIONS

Leighton's work was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional opinions included in this report.

This report has been prepared for the express use of KPFF and other design team members of this project, and only as related expressly to the assessment of soil and bedrock with respect to the geotechnical and geochemical constraints of developing the subject site and for construction purposes. This report may not be used by others or for other projects without the expressed written consent of KPFF, and our firm.

Any persons using this report for bidding or construction purposes should perform such independent investigations as they deem necessary to satisfy themselves as to the surface and/or subsurface conditions to be encountered and the procedures to be used in the performance of work on the subject site.

Project: 12115.001	Eng/Geol: VPI/JMP
Scale:1 " = 1,000 '	Date: May 2019

Base Map: ESRI ArcGIS Online 2019
Thematic Information: Leighton
Author: Leighton Geomatics (btran)

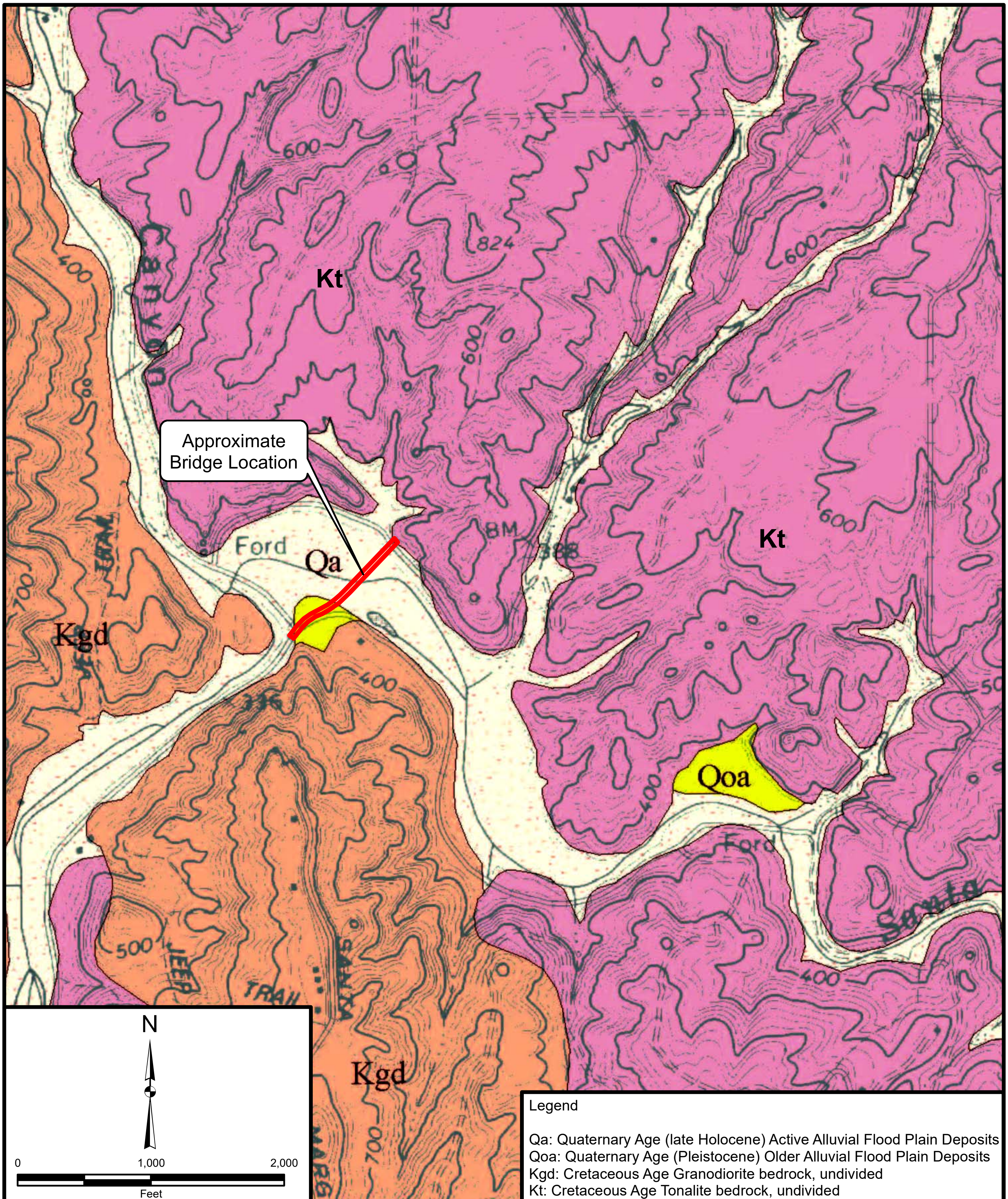
SITE LOCATION MAP

Sandia Creek Drive Bridge Replacement Project
San Diego County, California

Figure 1

Leighton

Map Saved as V:\Drafting\12115\001\Maps\12115-001_F01_SLM_2019-05-22.mxd on 5/22/2019 3:00:14 PM



Project: 12115.001	Eng/Geol: VPI/JMP
Scale:1 " = 1,000 '	Date: December 2019

Base Map: Geologic Map of the Temecula 7.5' Quadrangle San Diego and Riverside Counties, California
Thematic Information: Leighton, USGS
Author: Leighton Geomatics (btran)

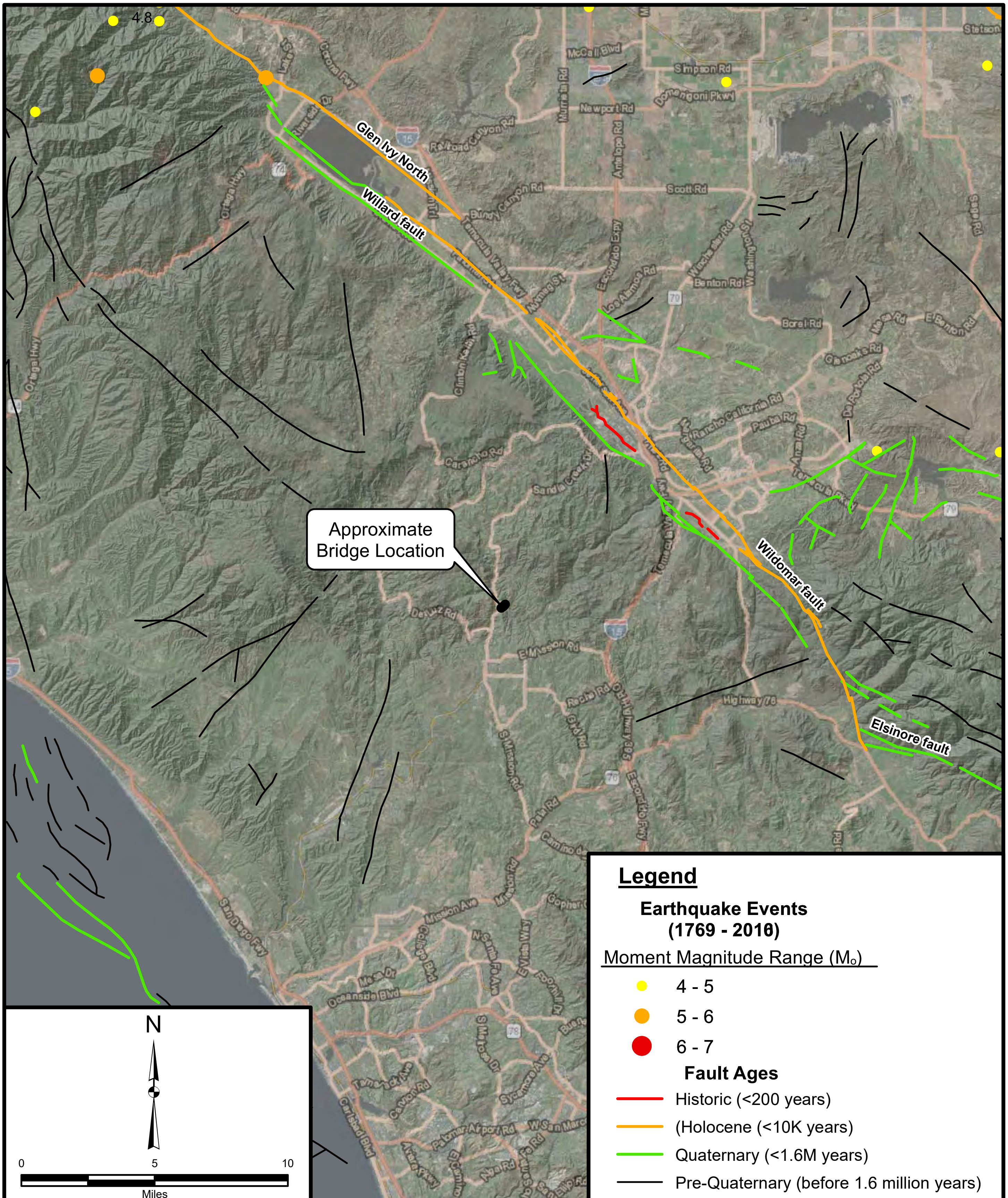
REGIONAL GEOLOGY MAP

Sandia Creek Drive Bridge Replacement Project
San Diego County, California

Figure 2

Leighton

Map Saved as V:\Drafting\12115\001\Maps\12115-001_F02_RGM_2019-12-11.mxd on 12/11/2019 9:27:32 AM



Project: 12115.001	Eng/Geol: VPI/JMP
Scale:1 " = 5 miles	Date: May 2019

Base Map: ESRI ArcGIS Online 2019
Thematic Information: Leighton, Bryant, W. A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0: CGS, USGS, SCEC.
Author: Leighton Geomatics (btran)

REGIONAL FAULT AND HISTORICAL SEISMICITY MAP

Sandia Creek Drive Bridge Replacement Project
San Diego County, California

Figure 3

Leighton

Map Saved as V:\Drafting\12115\001\Maps\12115-001_F03_RF&HSM_2019-05-22.mxd on 4/30/2019 4:59:21 PM

APPENDIX A

REFERENCES

APPENDIX A

References

AASHTO LRFD Bridge Design Specifications, 2012, Customary U.S. Units, 6th Edition.

American Concrete Institute (ACI), 2014, Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary, an ACI Standard, reported by ACI Committee 318.

American Society of Civil Engineers (ASCE), 2013, Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-10, Third Printing, Errata Incorporated through March 15.

Bryant, W.A., and Hart, E.W., Interim Revision 2007, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps: California Geological Survey, Special Publications 42, 42p.

California Building Standards Commission, 2016, 2016 California Building Code (CBC), California Code of Regulations, Title 24, Part 2, Volume 2 of 2, Based on 2015 International Building Code, Effective January 1, 2017.

California Department of transportation (Caltrans), 2013, Seismic Design Criteria, Version 1.7, April, 2013 and ARS Online.

California Geological Survey (CGS; formerly California Division of Mines and Geology, CDMG), 1990, Earthquake Fault Zones, Temecula Quadrangle, Official Map, released January 1, 1990, map scale 1:24,000.

_____, 2008, Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

______, 2018a, Seismic Hazard Zones, Temecula Quadrangle, California, Official Map, Released January 11, 2018.

______, 2018b, Seismic Hazard Zone Report for the Temecula 7.5-Minute Quadrangle, Riverside County, California, Seismic Hazard Zones Report 117.

______, 2018c, Earthquake Fault Zones, A Guide for Government Agencies, Property Owners / Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards in California, Special Publication 42, Revised 2018.

Campbell, K, and Bozorgnia, Y., 2008, "NGA ground motion model for the geometric mean horizontal component of PGA, PGV, PGD, and 5% damped linear elastic response spectra for periods ranging from 0.01 to 10s.", Earthquake Spectra, Vol 24, pp. 139-172

Chiou, B., and Youngs, R., 2008, "An NGA model for the average horizontal component of peak ground motion and response spectra", Earthquake Spectra, Vol 24, pp. 173-216

Diaz Yourman & Associates (DYA), 2018, (DRAFT) Preliminary Foundation Report, Replacement of the Existing Sandia Culvert Road Crossing Bridge (SMR02), San Diego County, California, Project No. 2017-038, dated March 15, 2018.

Kennedy, M.P., Tan, S.S., Bovard, K.R., Alvarez, R.M., Watson, M.J., and Gutierrez, C.I., 2007, Geologic Map of the Oceanside 30x60-minute Quadrangle, California: California Geological Survey, Regional Geologic Map No. 2, map scale 1:100,000.

Tan, S.S., and Kennedy, M.P., 2000, Geologic Map of the Temecula 7.5' Quadrangle, San Diego and Riverside Counties, California: A Digital Database, Version 1.0, United States Geological Survey, map scale 1:24,000.

United States Geological Survey (USGS), 1968, Photorevised 1975, Temecula Quadrangle California –7.5 Minute Series Topographic Map, map scale 1:24,000.

_____, 2008, National Seismic Hazard Maps – Fault Parameters, https://earthquake.usgs.gov/cfusion/hazfaults_2008_search/query_main.cfm

_____, 2014, Unified Hazard Tool, https://earthquake.usgs.gov/hazards/interactive/

_____, 2019a, Interactive Fault Map, http://earthquake.usgs.gov/hazards/qfaults/map/

_____, 2019b, Interactive Geologic Map, http://ngmdb.usgs.gov/maps/MapView/

NAVFAC 1986, Foundations and Earth Structures, Department of the Navy, Naval Facilities Engineering Command, DM7.2, p.7.2-60, May 1986.

APPENDIX B

SOUTHWEST GEOPHYSICS, INC.'S REPORT
DATED 02/26/2018

SEISMIC SURVEY
TROUT UNLIMITED SM RIVER FISH PASSAGE
FALLBROOK, CALIFORNIA

PREPARED FOR:
Diaz Yourman & Associates
1616 East 17th Street
Santa Ana, CA 92705

PREPARED BY:
Southwest Geophysics, Inc.
8057 Raytheon Road, Suite 9
San Diego, CA 92111

February 26, 2018
Project No. 118055

SOUTHWEST GEOPHYSICS, INC.
YOUR SUBSURFACE SOLUTION

February 26, 2018
Project No. 118055

Ms. Kelly M. Shaw
Diaz Yourman & Associates
1616 East 17th Street
Santa Ana, CA 92705

Subject: Seismic Survey
Trout Unlimited SM River Fish Passage
Fallbrook, California

Dear Ms. Shaw:

In accordance with your authorization, we have performed a seismic survey for the Trout Unlimited SM River Fish Passage project located in Fallbrook, California. Specifically, our survey consisted of performing six P-wave refraction traverses and five refraction microtremor (ReMi) profiles at the project site. The purpose of our study was to develop subsurface velocity profiles in the study area. Our services were conducted on February 5, 2018. This data report presents our survey methodology, equipment used, analysis, and results.

We appreciate the opportunity to be of service on this project. Should you have any questions related to this report, please contact the undersigned at your convenience.

Sincerely,
SOUTHWEST GEOPHYSICS, INC.

Aaron T. Puente
Project Geologist/Geophysicist

Hans van de Vrugt, C.E.G., P.Gp.
Principal Geologist/Geophysicist

REGISTERED GEOPHYSICIST Hans van de Vrugt No 1012 Exp. 2/28/18 STATE OF CALIFORNIA

ATP/HV

Distribution: (1) Addressee (electronic)

TABLE OF CONTENTS

1. INTRODUCTION

In accordance with your authorization, we have performed a seismic survey for the Trout Unlimited SM River Fish Passage project located in Fallbrook, California (Figure 1). Specifically, our survey consisted of performing six P-wave refraction traverses and five refraction microtremor (ReMi) profiles at the project site. The purpose of our study was to develop subsurface velocity profiles in the study area. This data report presents our survey methodology, equipment used, analysis, and results.

2. SCOPE OF SERVICES

Our scope of services included:

- Performance of six seismic P-wave refraction lines.
- Performance of five ReMi profiles.
- Compilation and analysis of the data collected.
- Preparation of this illustrated data report presenting our results.

3. SITE DESCRIPTION AND PROJECT DESCRIPTION

The project site is located along the Santa Margarita River just to the southwest of the intersection between Sandia Creek Drive and Rock Mountain Drive in Fallbrook, California (Figure 1). The study area included portions of the river valley. The area is generally flat and heavily vegetated. The seismic lines were located along the relatively open areas near the creek. Figures 2 and 3 depict the general site conditions in the study areas and along the seismic lines.

Based on our discussions with you, it is our understanding your office is conducting a geotechnical evaluation of the site for a proposed bridge. The results of our survey will be used in the formulation of design and construction parameters for the project.

4. SURVEY METHODOLOGY AND ANALYSIS

As previously indicated, the primary purpose of our services was to characterize the subsurface conditions at pre-selected locations through the collection of seismic data. The following sections provide an overview of the methodologies used during our study.

4.1. P-wave Refraction Survey

The seismic refraction method uses first-arrival times of refracted seismic waves to estimate the thicknesses and seismic velocities of subsurface layers. Seismic P-waves (compression waves) generated at the surface are refracted at boundaries separating materials of contrasting velocities. These refracted seismic waves are then detected by a series of surface vertical component 14-Hz geophones, and recorded with a 24-channel Geometrics Geode seismograph. The travel times of the seismic P-waves are used in conjunction with the shot-to-geophone distances to obtain thickness and velocity information on the subsurface materials. In general, the effective depth of evaluation for a seismic refraction traverse is approximately one-third to one-fifth the length of the traverse. The refraction method requires that subsurface velocities increase with depth. A layer having a velocity lower than that of the layer above will not generally be detectable by the seismic refraction method and, therefore, could lead to errors in the depth calculations of subsequent layers. In addition, lateral variations in velocity, such as those caused by buried boulders, fractures, dikes, etc. can result in the misinterpretation of the subsurface conditions.

Six seismic P-wave refraction traverses, SL-1 through SL-6 were conducted at the site. The location of the profiles, which were selected by your office, and the line lengths are depicted on Figure 2. Multiple shot points (signal generator locations) were conducted at the ends, midpoint, and intermediate points along the lines. The P-wave signal (shot) was generated using a 16-pound hammer and an aluminum plate.

In general, the seismic P-wave velocity of a material can be correlated to rippability (see Table 1 below), or to some degree "hardness." Table 1 is based on published information from the Caterpillar Performance Handbook (Caterpillar, 2011) as well as our experience with similar materials, and assumes that a Caterpillar D-9 dozer ripping with a single shank is used. We emphasize that the cutoffs in this classification scheme are approximate and that rock characteristics, such as fracture spacing and orientation, play a significant role in determining rock quality or rippability.

The collected data were processed using SIPwin (Rimrock Geophysics, 2003), a seismic interpretation program, and analyzed using SeisOpt Pro (Optim, 2008). SeisOpt Pro uses first arrival picks and elevation data to produce subsurface velocity models through a nonlinear optimization technique called adaptive simulated annealing. The resulting velocity model provides a tomography image of the estimated geologic conditions. Both vertical and lateral velocity information is contained in the tomography model. Changes in layer velocity are revealed as gradients rather than discrete contacts, which typically are more representative of actual conditions.

Table 1 – Rippability Classification	
Seismic P-wave Velocity	**Rippability**
0 to 2,000 feet/second	Easy
2,000 to 4,000 feet/second	Moderate
4,000 to 5,500 feet/second	Difficult, Possible Blasting
5,500 to 7,000 feet/second	Very Difficult, Probable Blasting
Greater than 7,000 feet/second	Blasting Generally Required

4.2. ReMi Survey

The refraction microtremor technique uses recorded surface waves (specifically Rayleigh waves) that are contained in the background noise to develop a shear wave velocity profile of the site. The depth of exploration is dependent on the length of the line and the frequency content of the background noise. The results of the ReMi method are displayed as a one-dimensional sounding which represents the average condition across the length of the line. Unlike the refraction method, described above, the ReMi method does not require an increase of material velocity with depth. Therefore, low velocity zones (velocity inversions) are detectable with ReMi. Additionally, the ReMi method is not substantially affected by the presence of the groundwater table like the P-wave refraction method; therefore, ReMi data together with P-wave data can often be used to delineate the groundwater table. Typical P-wave velocities for the water table are on the order of 5,000 feet per second.

Five ReMi lines, RL-1 through RL-5, were performed at the project. Each profile consisting of fifteen records, 30 seconds long were collected with a 24-channel Geometrics Geode seismograph and 4.5-Hz vertical component geophones.

Collected ReMi data were processed using SeisOpt® ReMi™ software (© Optim LLC, 2005), which uses the refraction microtremor method (Louie, 2001). The program generates phase-velocity dispersion curves for each record and provides an interactive dispersion modeling tool where the users determine the best fitting model. The result is a one-dimensional shear-wave velocity model of the site with roughly 85 to 95 percent accuracy.

5. RESULTS

Figures 4a through 4f present the P-wave refraction results for SL-1 through SL-6, respectively, and Figures 5a through 5c present the ReMi results for RL-1, RL-4, and RL-5, respectively. Please note that due to poor data quality the results for RL-3 and RL-6 are not presented.

Based on the velocity models generated from our P-wave analysis it appears that the study areas are underlain by low velocity materials (e.g., colluvium, alluvium and topsoil) in the very near surface, and bedrock with varying degrees of weathering at depth. Distinct vertical and lateral velocity variations are evident in the models. Moreover, the degree of bedrock weathering and the depth to bedrock appears to be variable across the study areas. In addition, remnant boulders appear to be present in the subsurface. The results from the ReMi survey also indicate the present of low velocity materials in the near surface and higher velocity materials at depth. In general, the results from RL-1, RL-4 and RL-5 roughly agree with the results from SL-1, SL-5 and SL-6, respectively. It should be emphasized that the ReMi results represent an average condition across the length of the line at that the resulting models are a simplified one dimensional S-wave velocity model.

6. LIMITATIONS

The field evaluation and geophysical analyses presented in this report have been conducted in general accordance with current practice and the standard of care exercised by consultants performing similar tasks in the project area. No warranty, express or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be present. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface surveying will be performed upon request.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Southwest Geophysics, Inc. should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

7. SELECTED REFERENCES

Iwata, T., Kawase, H., Satoh, T., Kakehi, Y., Irikura, K., Louie, J. N., Abbott, R. E., and Anderson, J. G., 1998, Array Microtremor Measurements at Reno, Nevada, USA (abstract): Eos, Trans. Amer. Geophys. Union, v. 79, suppl. to no. 45, p. F578.

Louie, J, N., 2001, Faster, Better, Shear-Wave Velocity to 100 Meters Depth from Refraction Microtremor Arrays: Bulletin of the Seismological Society of America, v. 91, p. 347-364.

Mooney, H.M., 1976, Handbook of Engineering Geophysics, dated February.

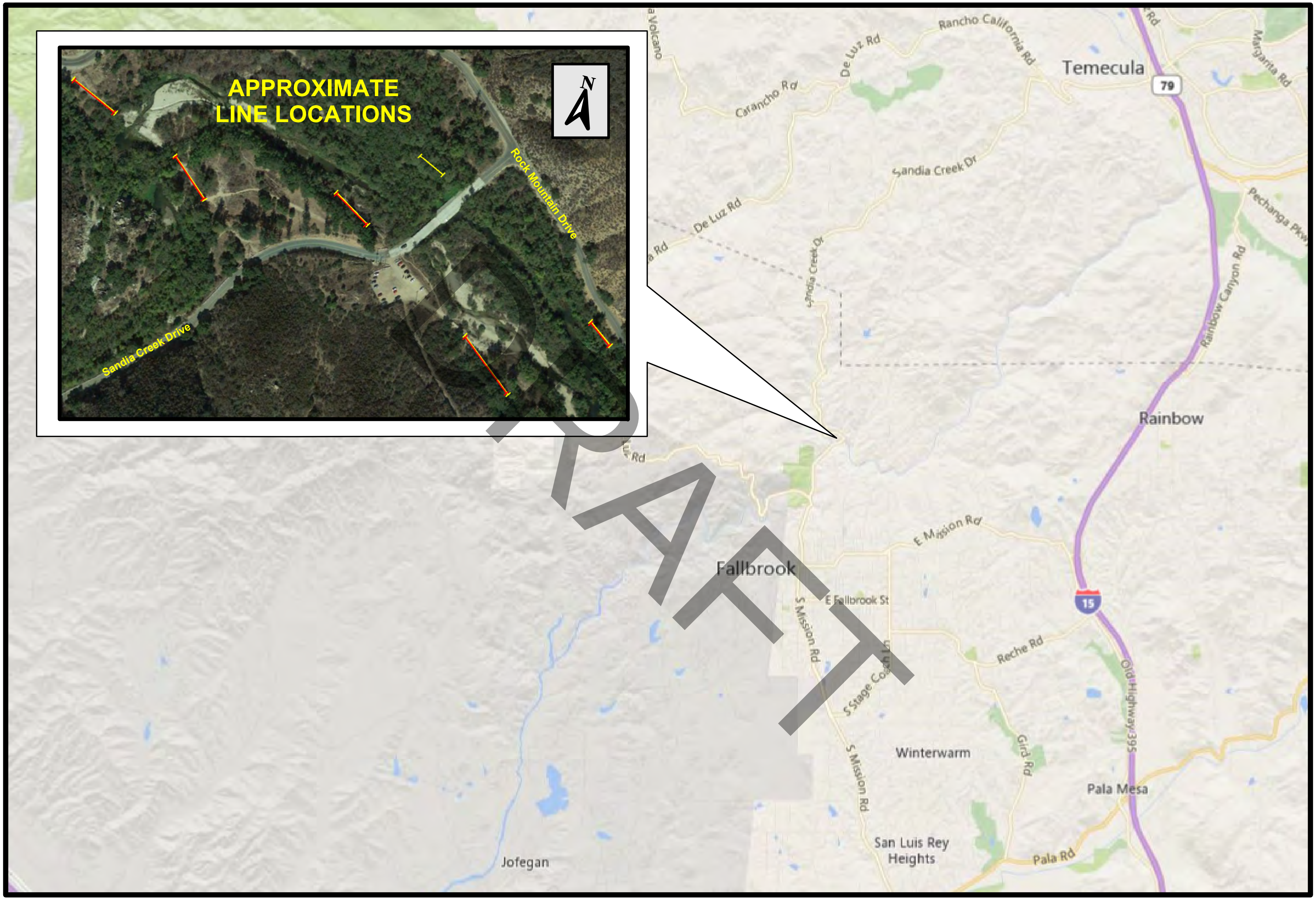
Optim, 2005, SeisOpt ReMi Analysis Software, V-3.0.

Rimrock Geophysics, 2003, Seismic Refraction Interpretation Program (SIPwin), V-2.76.

Saito, M., 1979, Computations of Reflectivity and Surface Wave Dispersion Curves for Layered Media; I, Sound wave and SH wave: Butsuri-Tanko, v. 32, no. 5, p. 15-26.

Saito, M., 1988, Compound Matrix Method for the Calculation of Spheroidal Oscillation of the Earth: Seismol. Res. Lett., v. 59, p. 29.

Telford, W.M., Geldart, L.P., Sheriff, R.E., and Keys, D.A., 1976, Applied Geophysics, Cambridge University Press.



SITE LOCATION MAP

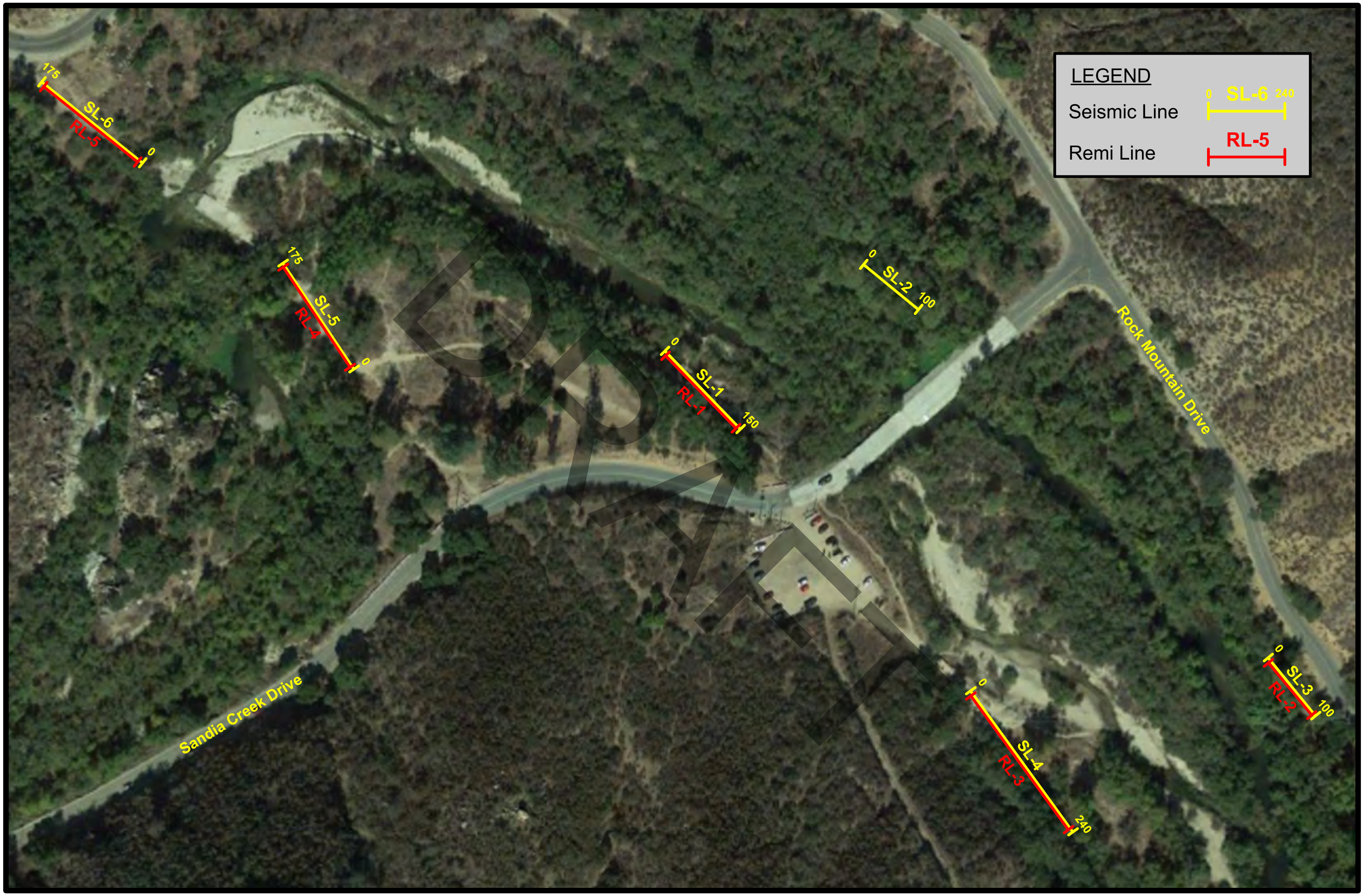
N

Trout Unlimited SM River Fish Passage
Fallbrook, California

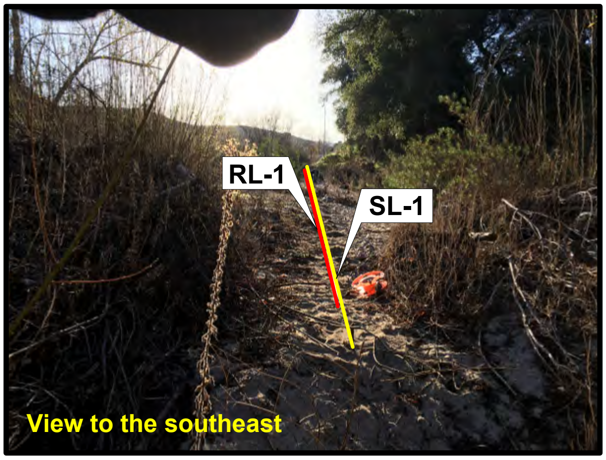
Project No.: 118055 | Date: 02/18

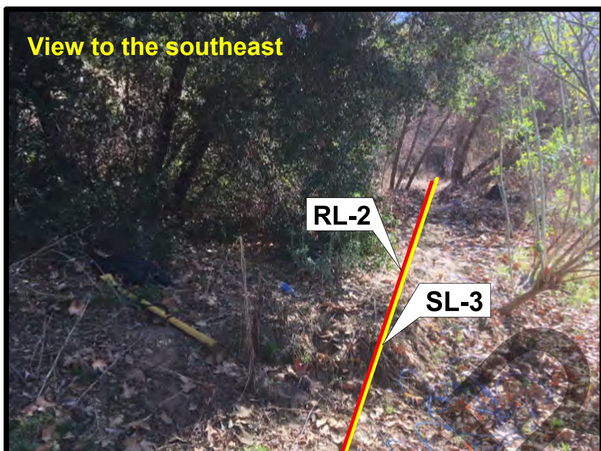
SOUTHWEST GEOPHYSICS INC.

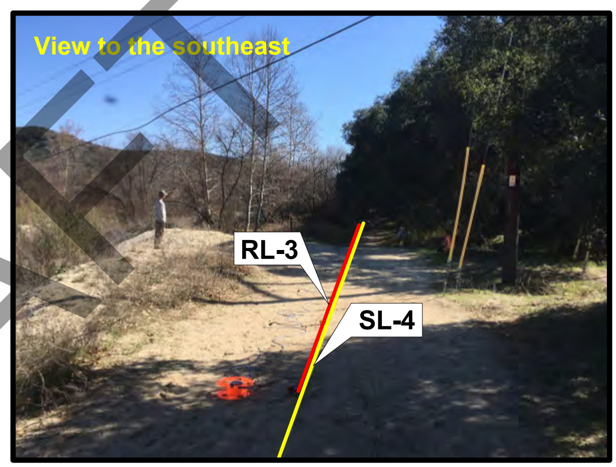
Figure 1

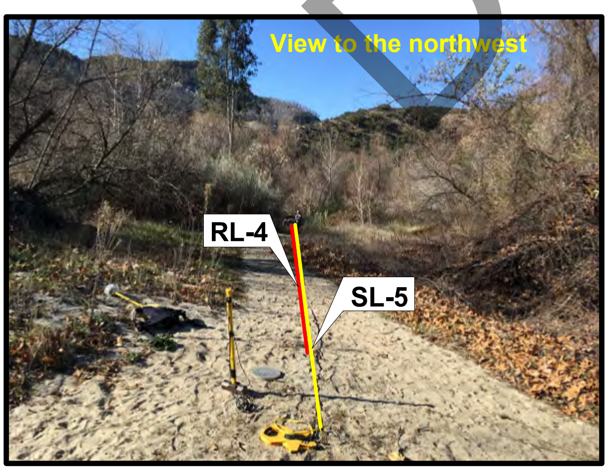


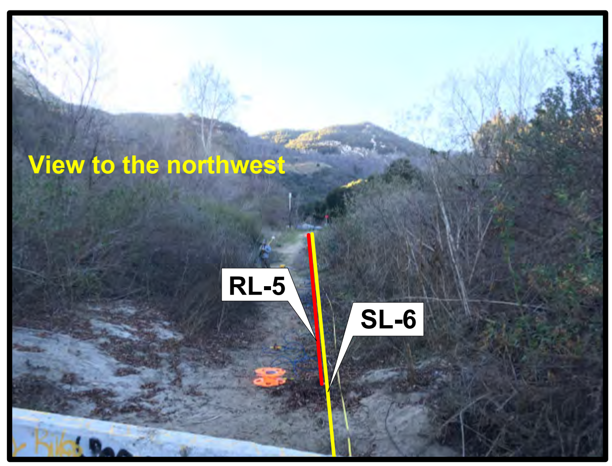
LINE LOCATION MAP	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 2	





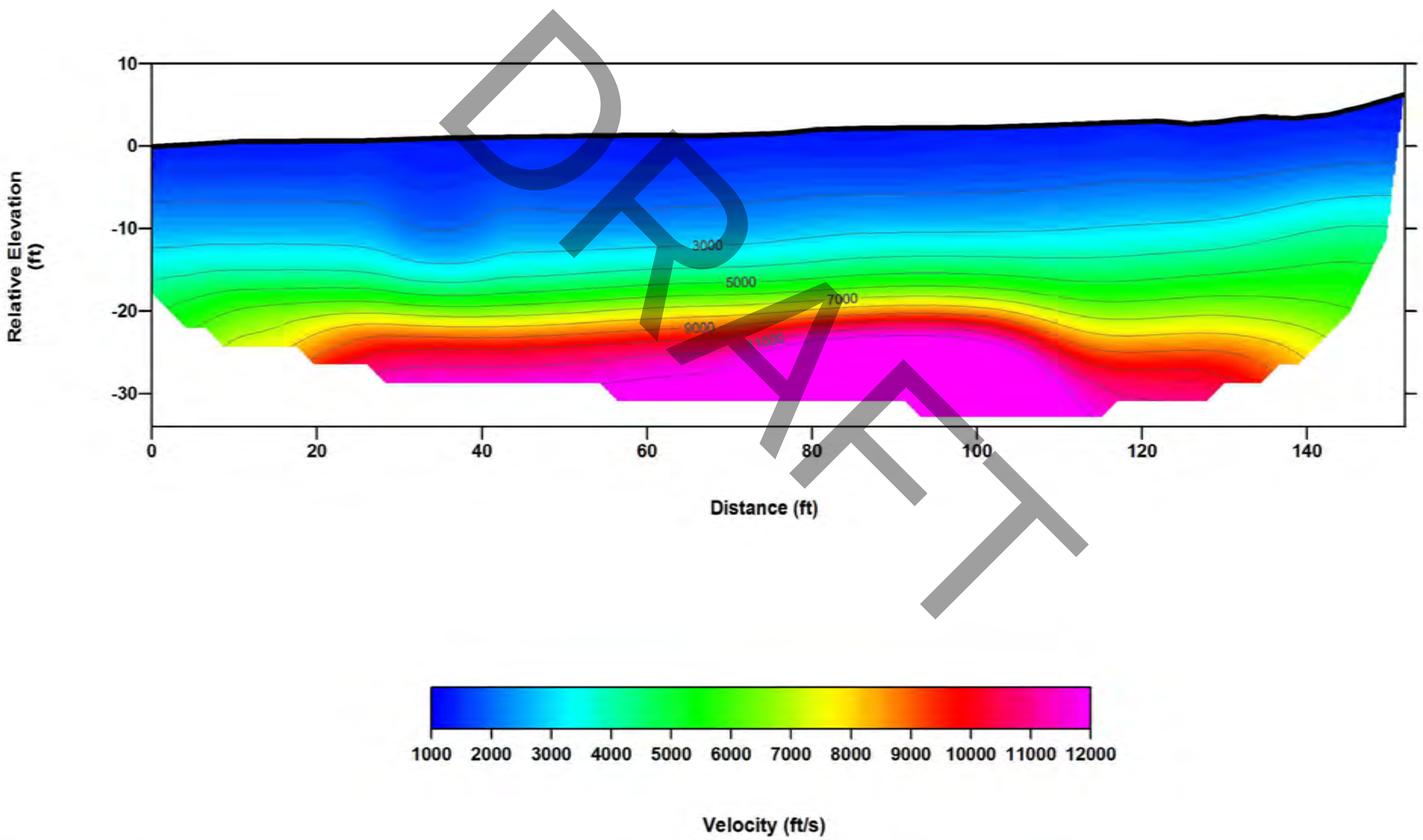






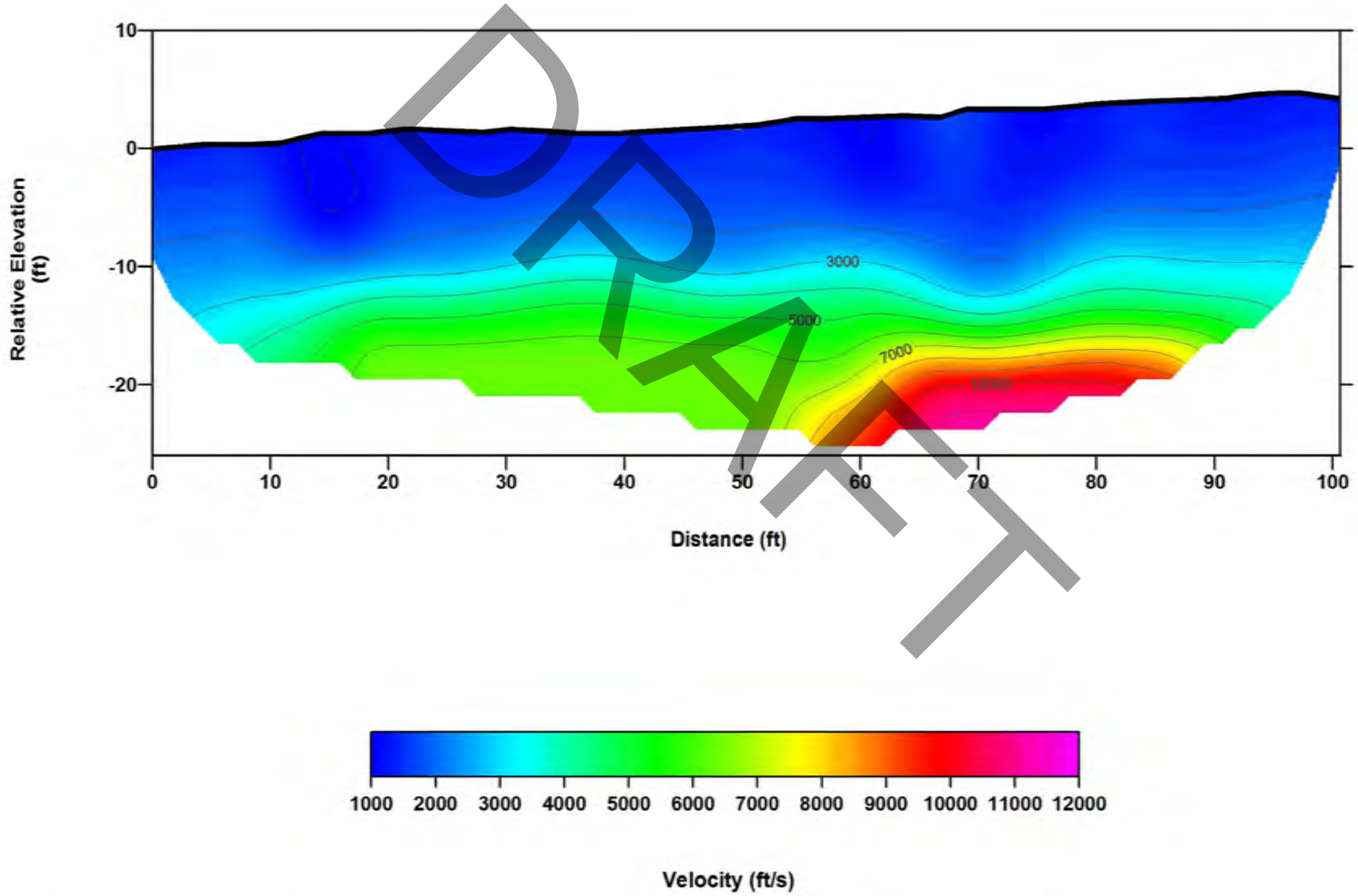
SITE PHOTOGRAPHS	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 / Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 3

TOMOGRAPHY MODEL



P-WAVE PROFILE SL-1	Trout Unlimited SM River Fish Passage Fallbrook, California	SOUTHWEST GEOPHYSICS INC. Figure 4a	Note: Contour Interval = 1,000 feet per second
	Project No.: 118055 Date: 02/18		

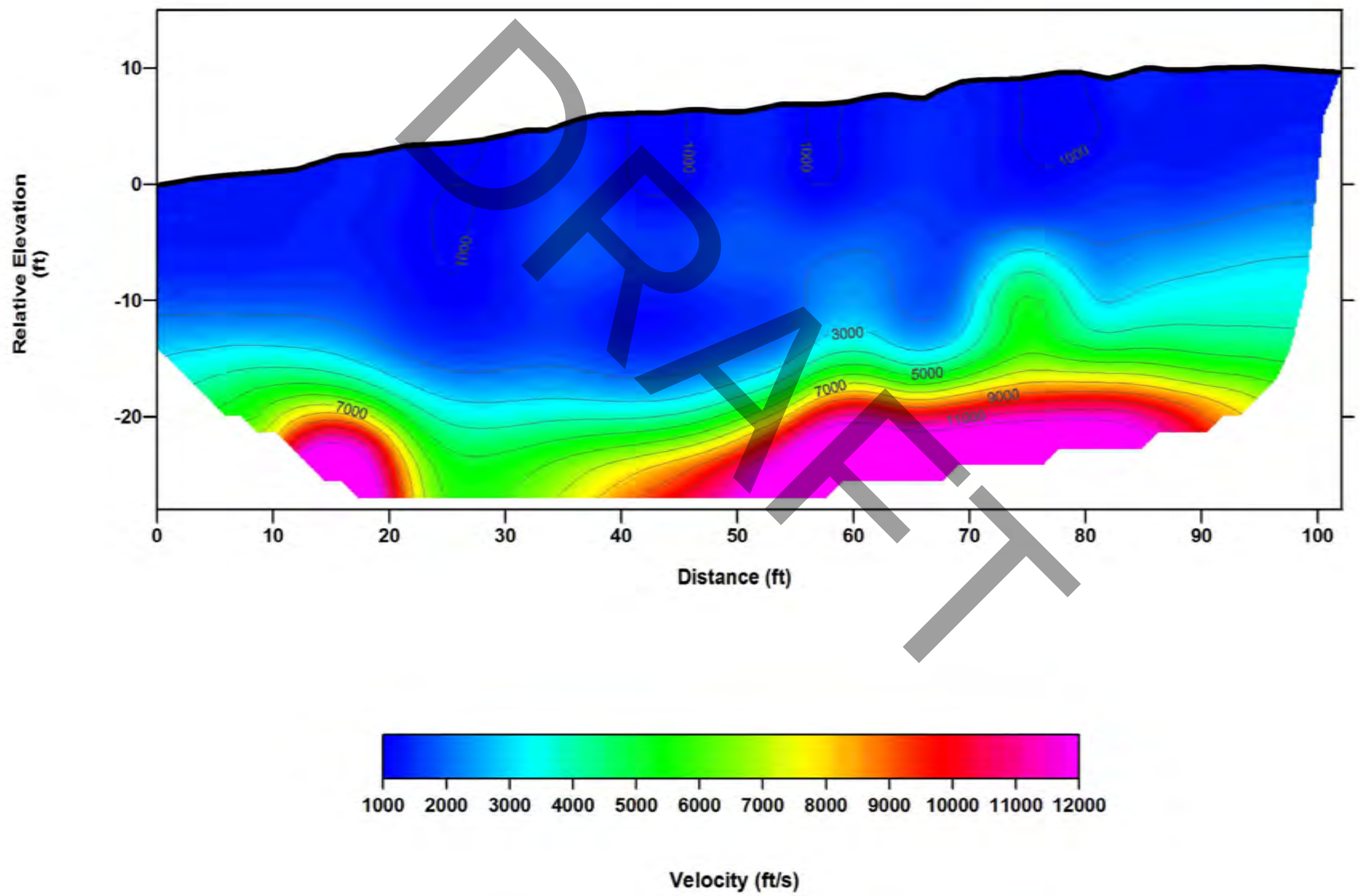
TOMOGRAPHY MODEL



P-WAVE PROFILE SL-2	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 — Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 4b

Note: Contour Interval = 1,000 feet per second

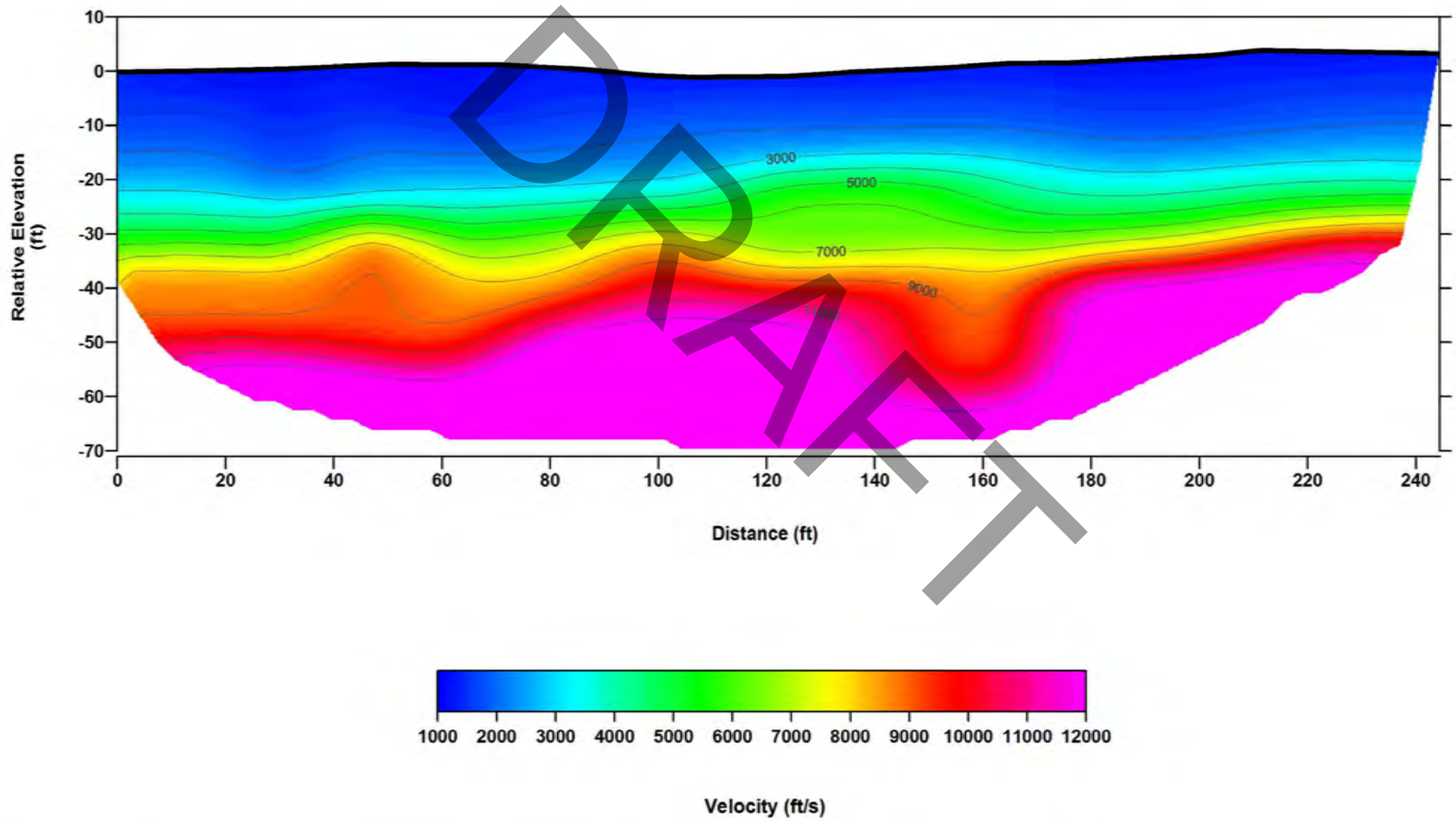
TOMOGRAPHY MODEL



P-WAVE PROFILE SL-3	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 — Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 4c

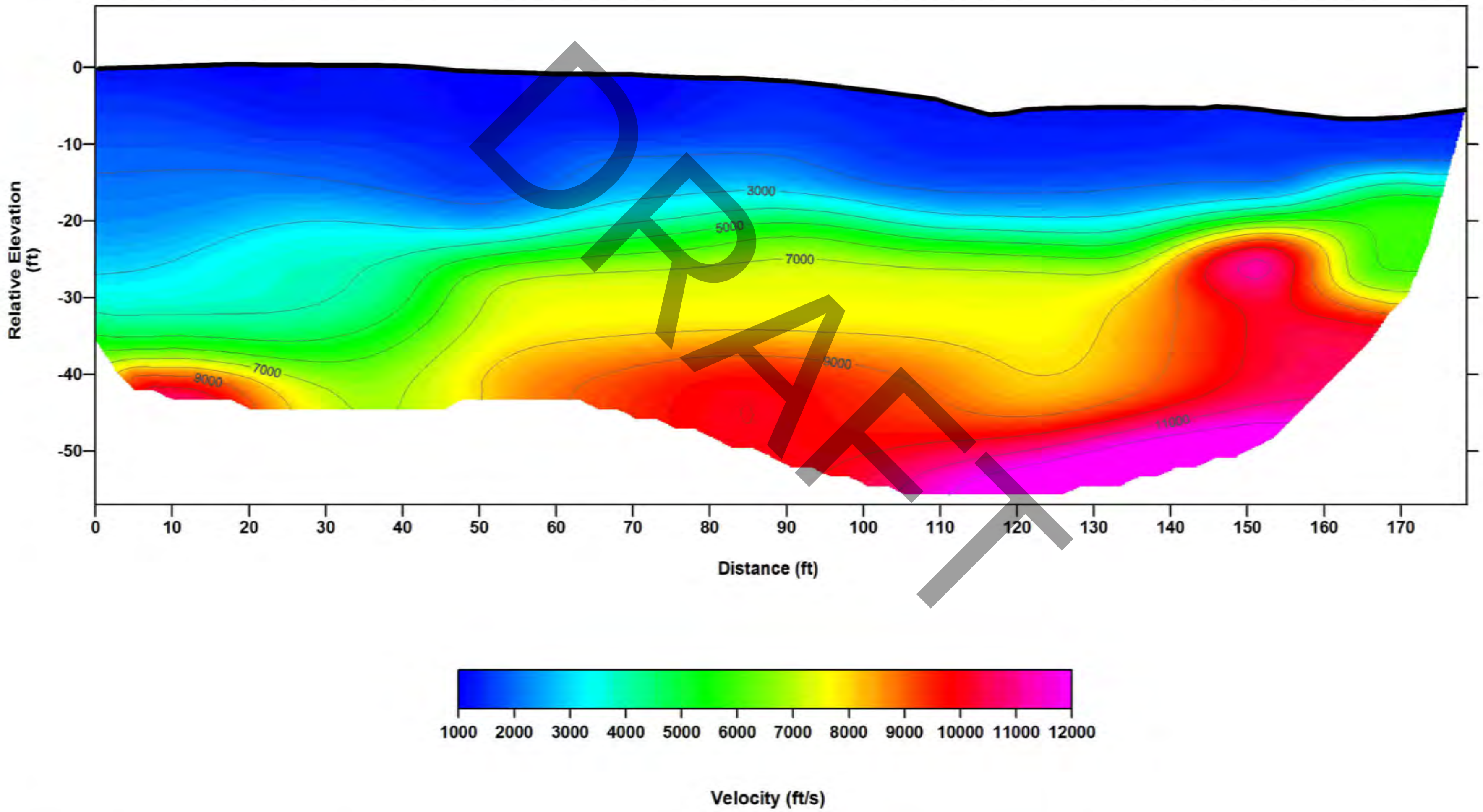
Note: Contour Interval = 1,000 feet per second

TOMOGRAPHY MODEL



P-WAVE PROFILE SL-4	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 — Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 4d	Note: Contour Interval = 1,000 feet per second

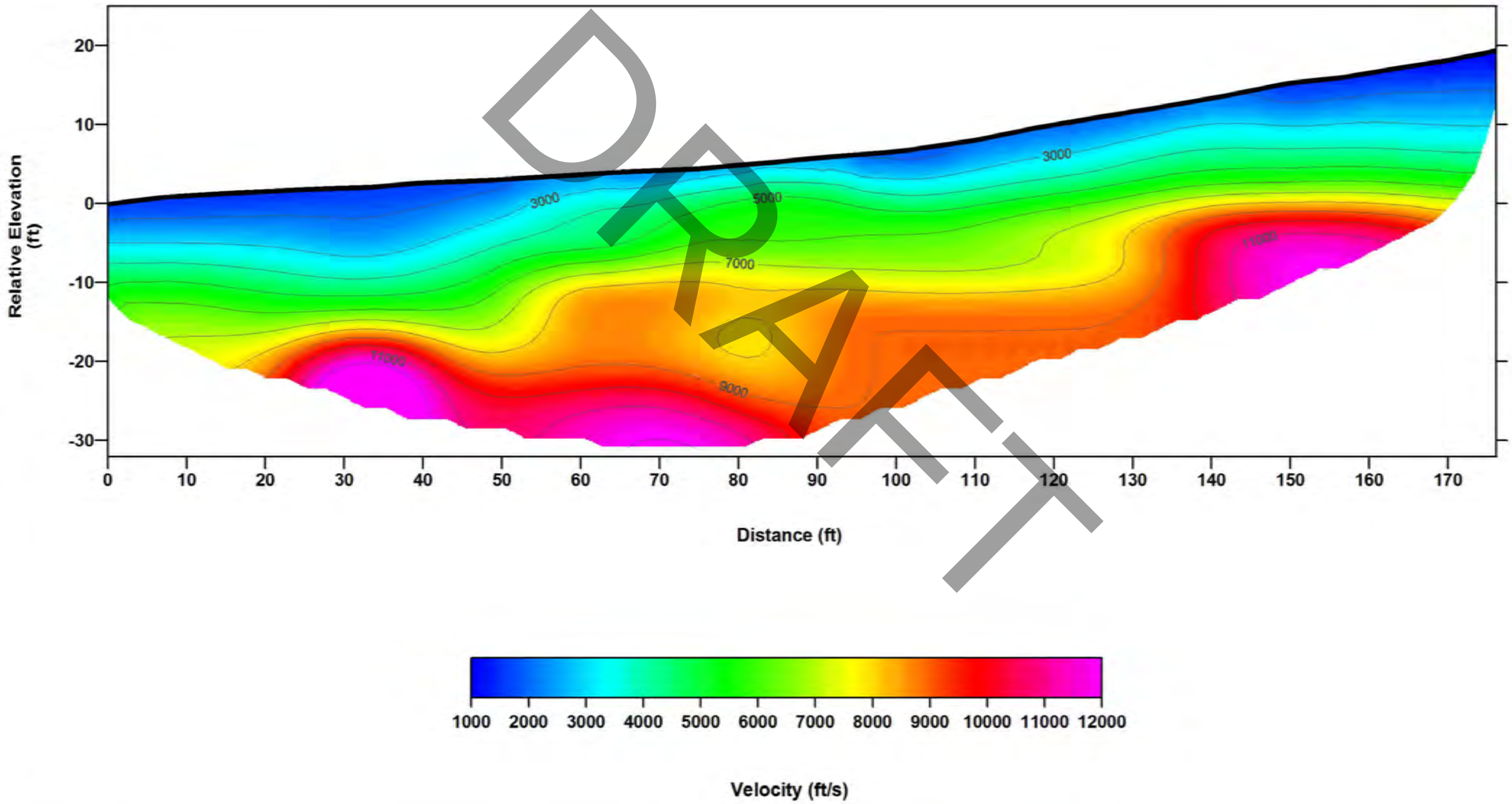
TOMOGRAPHY MODEL



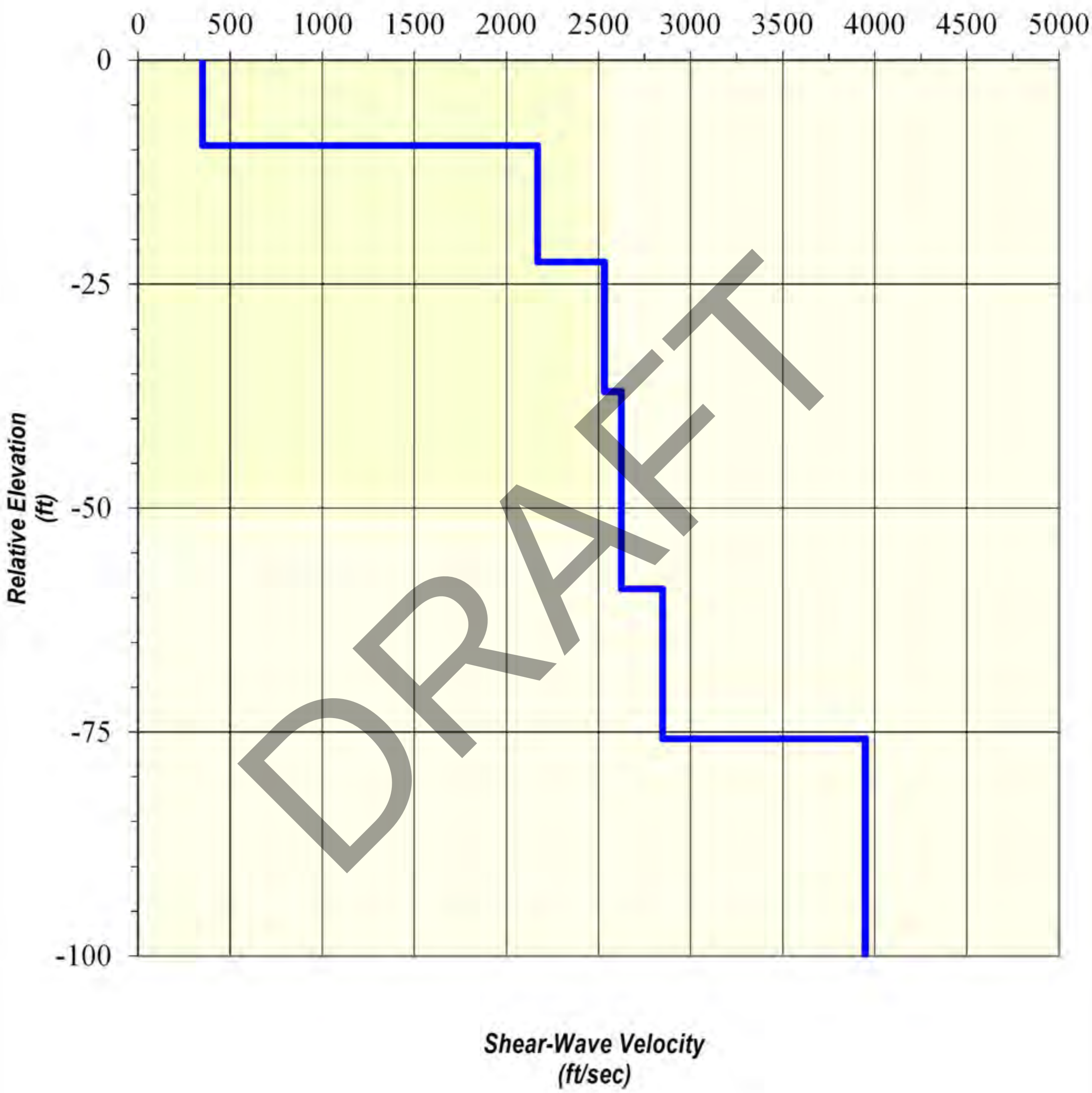
P-WAVE PROFILE SL-5	Trout Unlimited SM River Fish Passage Fallbrook, California		SOUTHWEST GEOPHYSICS INC. Figure 4e
	Project No.: 118055	Date: 02/18	

Note: Contour Interval = 1,000 feet per second

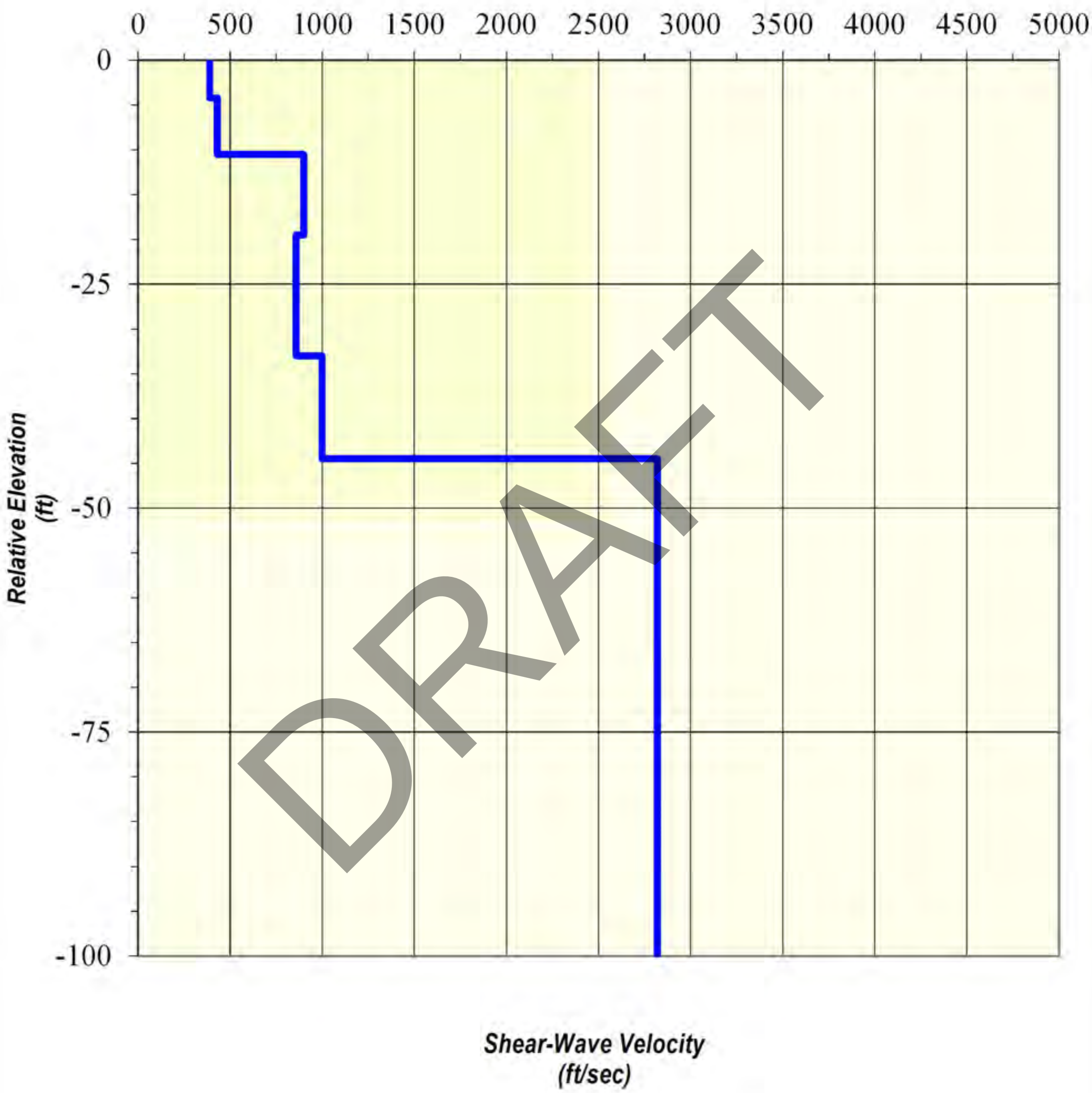
TOMOGRAPHY MODEL



P-WAVE PROFILE SL-6	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 — Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 4f	Note: Contour Interval = 1,000 feet per second



ReMi RESULTS **RL-1**	Trout Unlimited SM River Fish Passage Fallbrook, California Project No.: 118055 — Date: 02/18	SOUTHWEST GEOPHYSICS INC. Figure 5a



ReMi RESULTS
RL-4

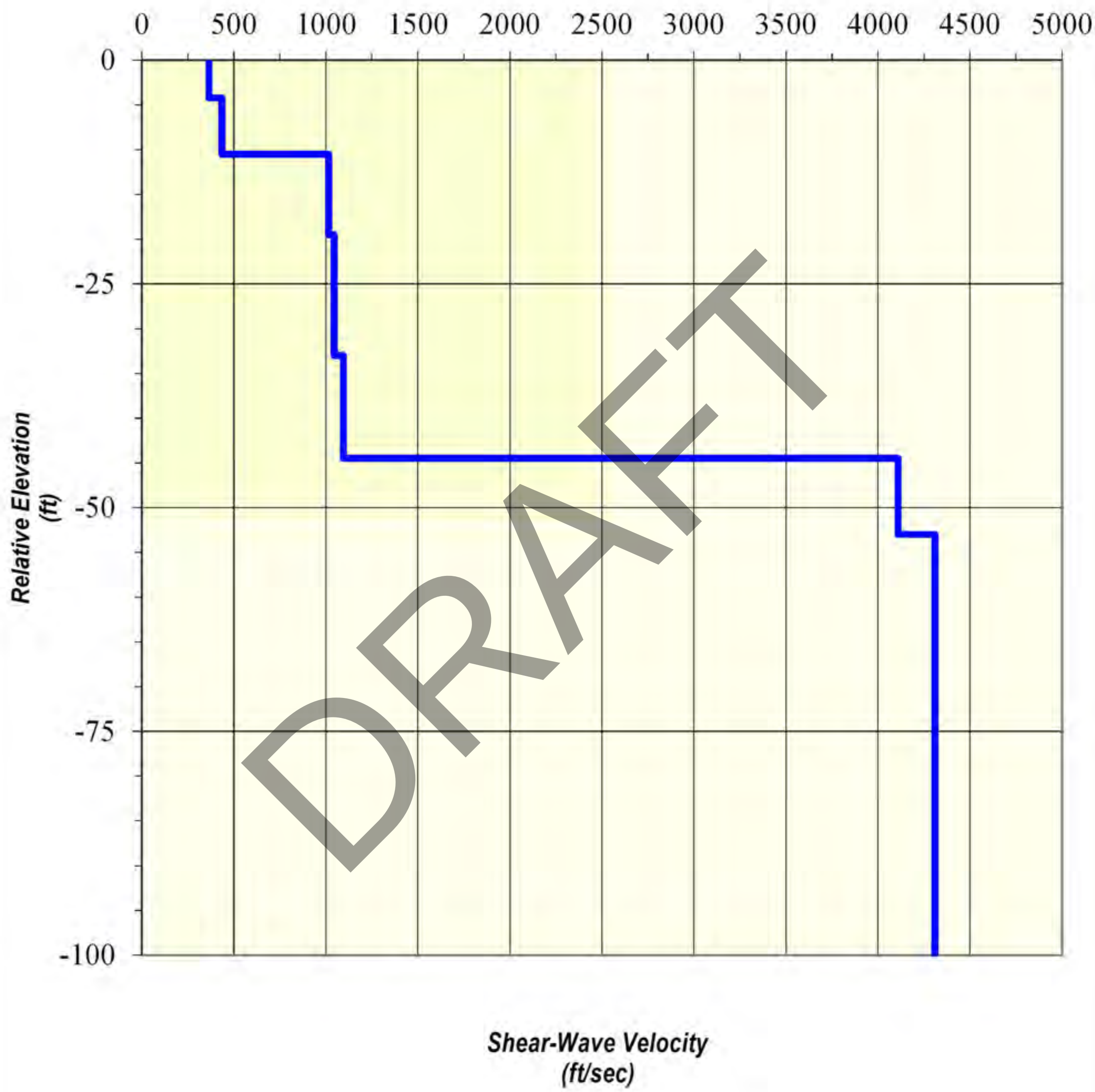
Trout Unlimited SM River Fish Passage
Fallbrook, California

Project No.: 118055

Date: 02/18

SOUTHWEST GEOPHYSICS INC.

Figure 5b



ReMi RESULTS
RL-5

Trout Unlimited SM River Fish Passage
Fallbrook, California

Project No.: 118055

Date: 02/18

SOUTHWEST GEOPHYSICS INC.

Figure 5c

APPENDIX B -
GEOLOGY

APPENDIX B - GEOLOGIC EVALUATION

B.1 Regional Geology and Faulting

The Sandia Road site at the Santa Margarita River is located within the Peninsular Ranges geomorphic province, which is characterized by generally northwest trending mountains and valleys, located south of the Transverse Ranges, and west of the Mojave and Colorado Deserts. Offshore continental borderland areas south of the Transverse Ranges also are included within the Peninsular Ranges. Landforms and topography (physiography) around the Project Area are controlled by the distribution and character of geologic units, by fault movements, and by climate and erosion, all of which contribute to the sculpture of the landscape. The generally north to northwest trending coastline and mountains to the east are influenced by the Newport-Inglewood-Rose Canyon (offshore to the west) and the Elsinore-Temecula fault zones (to the east), respectively.

The distribution of geologic formations within the Project Area is discussed below. The published geologic map reviewed for this study is the U. S. Geological Survey map for the Temecula 7.5-minute quadrangle (Kennedy and Tan, 2000; Figure 1). The USGS authors Kennedy and Tan (2000) compiled a regional geologic map, which in the Project Area includes geologic structure (bedding attitudes) and a reasonably simple view of the distribution of geologic units (distinguishing bedrock and surficial units into broad groupings) as shown on Figure 1. Figure 1 provides a brief description of these geologic formations (Kennedy and Tan, 2008), from youngest to oldest, present in the Project Area.

The Rose Canyon fault zone is considered the southern extension of the Newport-Inglewood structural zone originating at the Santa Monica Mountains and continuing south-southeast into the offshore at Huntington Beach, then returning onshore near La Jolla and Soledad Mountain. The Elsinore-Temecula fault zone is a major right-lateral shear system parallel to the southern San Andreas and San Jacinto faults in the southeast portion of the Peninsular Ranges. Both faults have documented Holocene activity and are capable of earthquakes of approximately magnitude 7.0.

B.2 Project Area Geology

Previous regional mapping in the covering the project area (Tan and Kennedy, 2000) indicates younger alluvium (map symbol Qa), older alluvium (Qoa), and granitic bedrock (Kr and Kgd) are present (Figure 1). For this evaluation we will describe the geologic units for the locations of Option 1 and Option 3 (the proposed abutments and the areas in between) indicated on Figure 1. For consistency the same unit symbols are used for the area-specific mapping (Figure 2) with alluvial unit subdivisions of Qa1, Qa2, Qa3, Qoa1, and Qoa2. Option 1 overlies surface geologic units Qa, Qa1, Qa2, and Qa3, while Option 3 overlies surface geologic units Qa, Qa1, and Qa2. In addition, in the subsurface below these mapped units at the proposed abutment locations Qoa1, Qoa2, Kr, and Kgd would be encountered. The depths to these various subsurface units can be approximated using the seismic survey p-wave velocity data (Southwest Geophysics, Inc., 2018) for lines SR-1 and SR-2 (Option1) and SR-5 and SR-6 for Option 3.

Descriptions of the above-mention alluvium and bedrock units are shown on Figure 2. Based on the geologic mapping and the seismic data the conditions at each abutment area are described below. Accurate depth estimates can only be made after geotechnical drilling data are acquired at each abutment location.

Option 1: The southwest abutment area is underlain by Qa, Qa1, and possibly Qa3. Seismic data indicate these deposits are likely to be less than 10-feet thick and are underlain immediately by Qoa2 and Kgd. Younger alluvium and Qoa2 combined may be 10- to 12 feet thick and Kgd should be encountered in the 12- to 20-feet depth range with 7,000 feet per second (marginally to non-rippable; Caterpillar Inc., 2000) likely encountered between 20- and 25-feet depth. The northeast abutment is underlain by Qa3. Seismic data indicate this deposit is likely to be less than 10- to 12-feet feet thick and is underlain immediately by Qoa2 and Kr. Younger alluvium and Qoa2 combined may be 10- to 12 feet thick and Kr should be encountered in the 12- to 15-feet depth range with 7,000 feet per second (marginally to non-rippable) likely encountered between 15- and 20-feet depth.

Option 3: The southeast abutment area is underlain by Qa2 and/or Qa3. Seismic data indicate these deposits are likely to be less than 10-feet thick and are underlain immediately by Qoa2 and Kr. Younger alluvium and Qoa2 combined may be 8- to -15 feet thick and Kr should be encountered in the 15-feet depth range with 7,000 feet per second (marginally to non-rippable) likely encountered at approximately 20-feet depth. The northwest abutment is underlain by Qa2 and/or Qa3. Seismic data indicate this deposit is likely to be less than 8- to 10-feet feet thick and is underlain immediately by Qoa2 and Kr. Younger alluvium and Qoa2 combined may be 12-feet thick and Kr should be encountered in the 12- to 15-feet depth range with 7,000 feet per second (marginally to non-rippable) likely encountered between 10- and 20-feet depth.

REFERENCES CITED

Caterpillar Inc., 2000, Handbook of Ripping – Twelfth Edition, 32 pages.

Tan, Siang. S. and Michael P. Kennedy, 2000, Geologic Map of the 7.5' Temecula Quadrangle, San Diego and Riverside Counties, California: A Digital Database, Version 1.0, California Division of Mines and Geology, scale 1:24,000, 1-inch = 2000-feet.

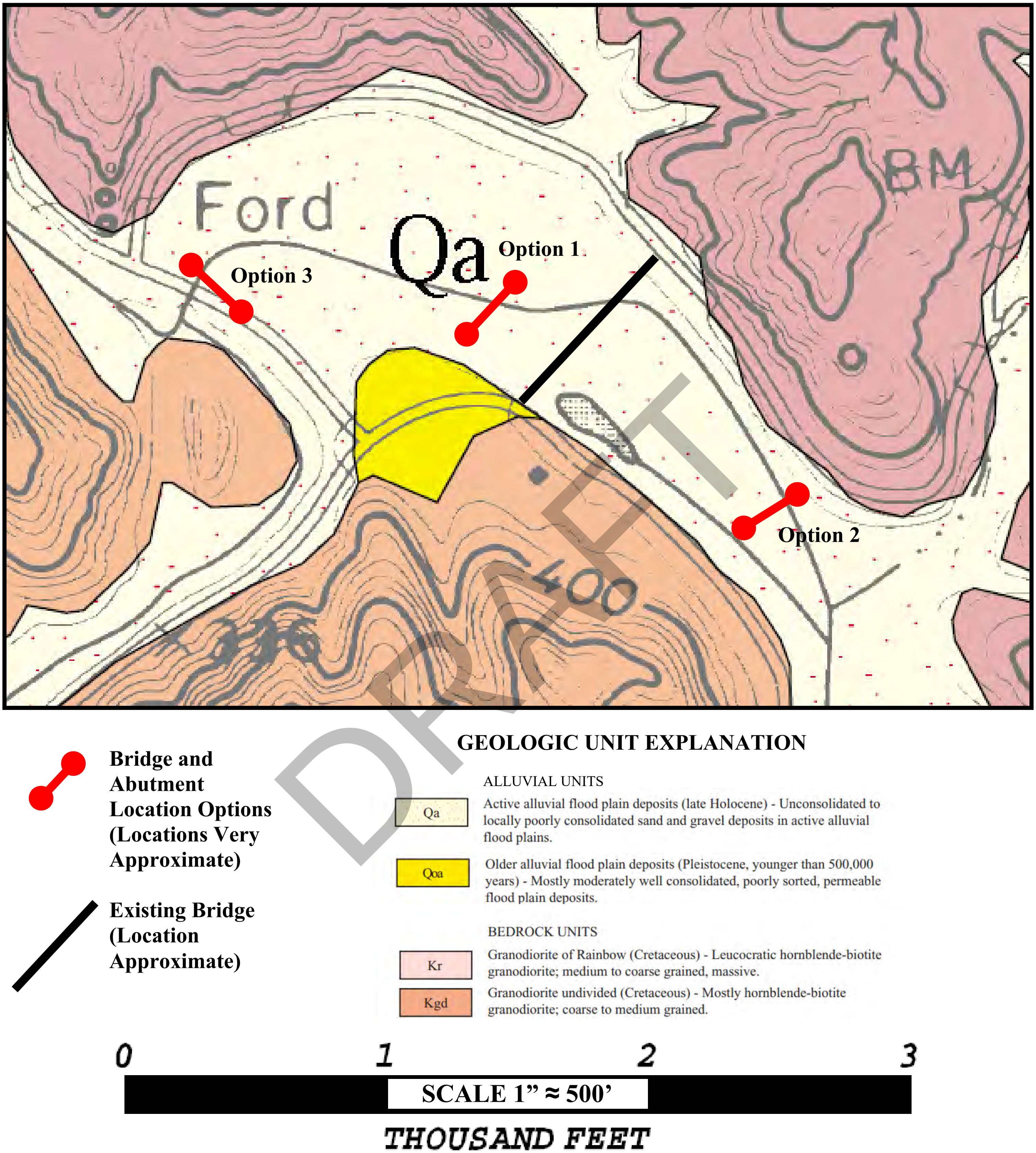
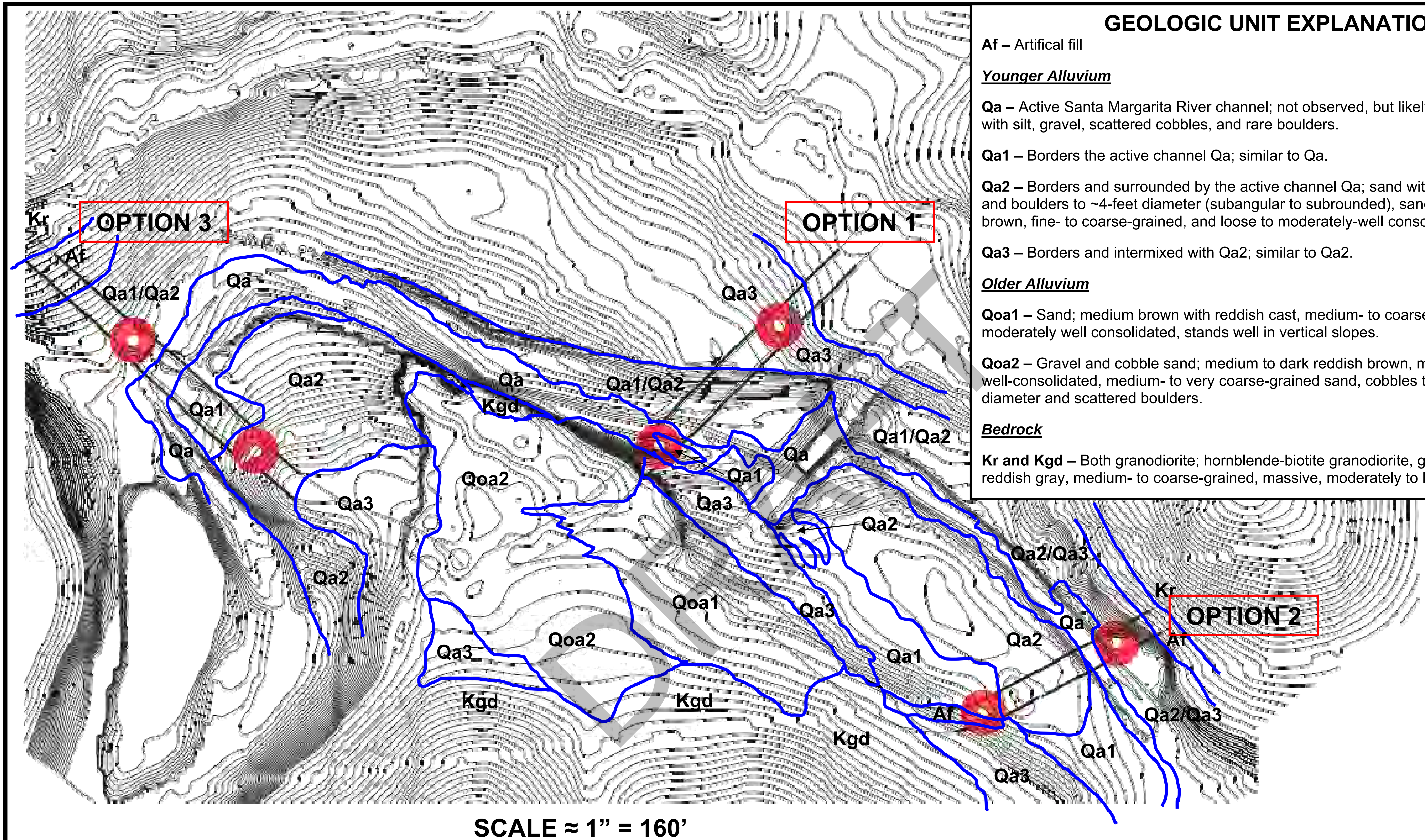


Figure 1 - Regional Geologic Map (USGS; Kennedy and Tan, 2000)



GEOLOGIC UNIT EXPLANATION

Af – Artifical fill

Younger Alluvium

Qa – Active Santa Margarita River channel; not observed, but likely consists of sand with silt, gravel, scattered cobbles, and rare boulders.

Qa1 – Borders the active channel Qa; similar to Qa.

Qa2 – Borders and surrounded by the active channel Qa; sand with gravel, cobbles, and boulders to ~4-feet diameter (subangular to subrounded), sand is medium gray-brown, fine- to coarse-grained, and loose to moderately-well consolidated.

Qa3 – Borders and intermixed with Qa2; similar to Qa2.

Older Alluvium

Qoa1 – Sand; medium brown with reddish cast, medium- to coarse-grained, moderately well consolidated, stands well in vertical slopes.

Qoa2 – Gravel and cobble sand; medium to dark reddish brown, moderately-well to well-consolidated, medium- to very coarse-grained sand, cobbles to 10-inches diameter and scattered boulders.

Bedrock

Kr and Kgd – Both granodiorite; hornblende-biotite granodiorite, greenish-gray to reddish gray, medium- to coarse-grained, massive, moderately to highly weathered.

FIGURE 2 – Project Area Geologic Map

APPENDIX C

LABORATORY TEST RESULTS

Leighton

COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	931-003A	Boring:	LB-1	Date:	3/13/2019
Client:	Leighton Consulting	Sample:	2	By:	PJ
Project Name:	Sandia Creek Road Bridge Replacement Proj.	Depth,ft.:	38.2-38.7	Checked:	DC
Project No.:	12115.001				

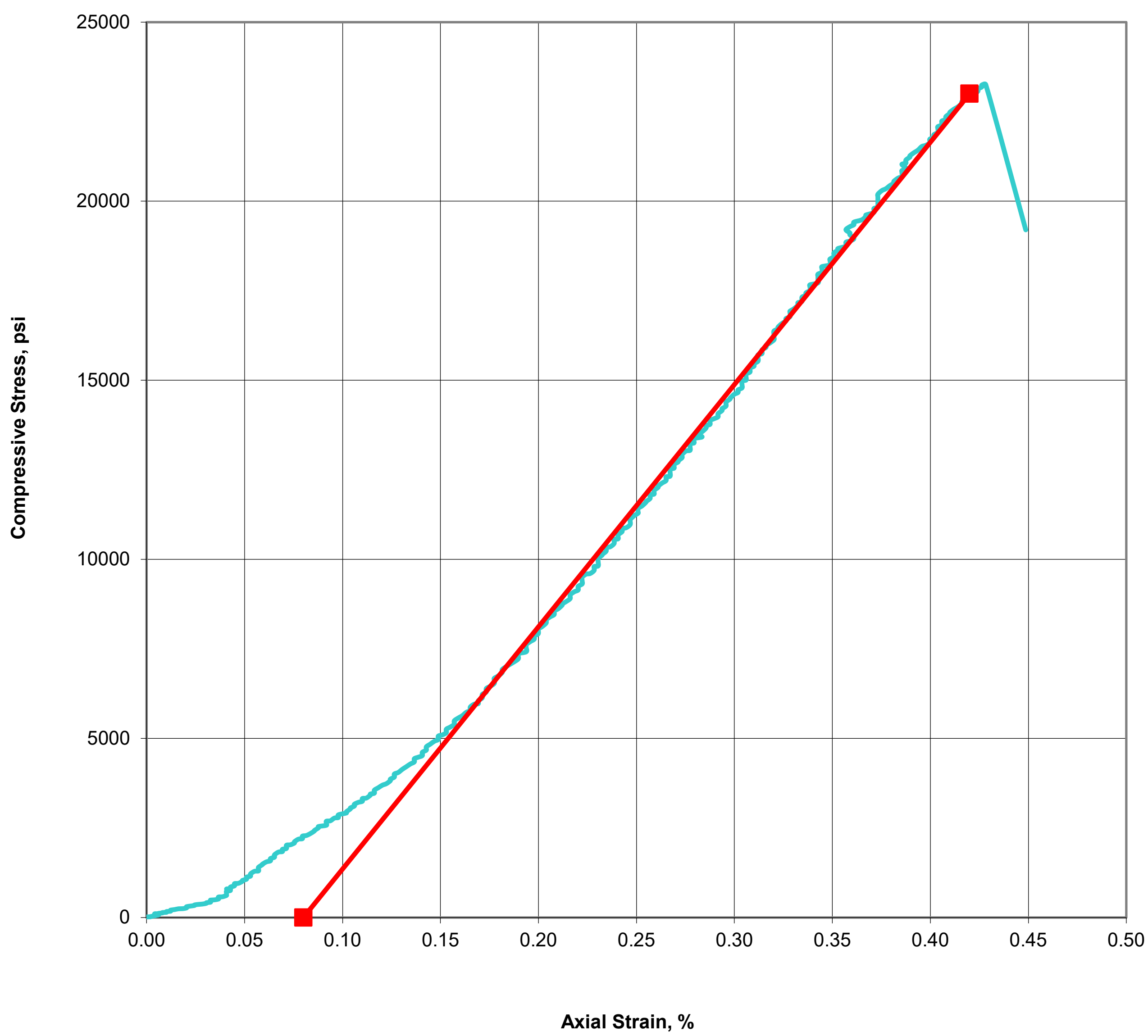
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (°C): Ambient

Remarks:

Sample Height, in.	4.90	**Unconfined Compressive Strength (psi)**	**23255**
Sample Diameter, in.	2.37		
Height / Diameter	2.1		
Sample Area, in²	4.43		
Wet Density, pcf	173.0	**Young's Modulus (E) (psi)**	**6,760,000**
Dry Density, pcf	172.3		
Moisture Content, %	0.4		
Strain Rate, % / min	0.25		



COOPER TESTING LABORATORY

Unconfined Compressive Strength and Young's Modulus of Rock Core (ASTM D7012D)

CTL Job No.:	931-003B	Boring:	LB-2	Date:	3/13/2019
Client:	Leighton Consulting	Sample:	2	By:	PJ
Project Name:	Sandia Creek Road Bridge Replacement Proj.	Depth,ft.:	62.6-63.4	Checked:	DC
Project No.:	12115.001				

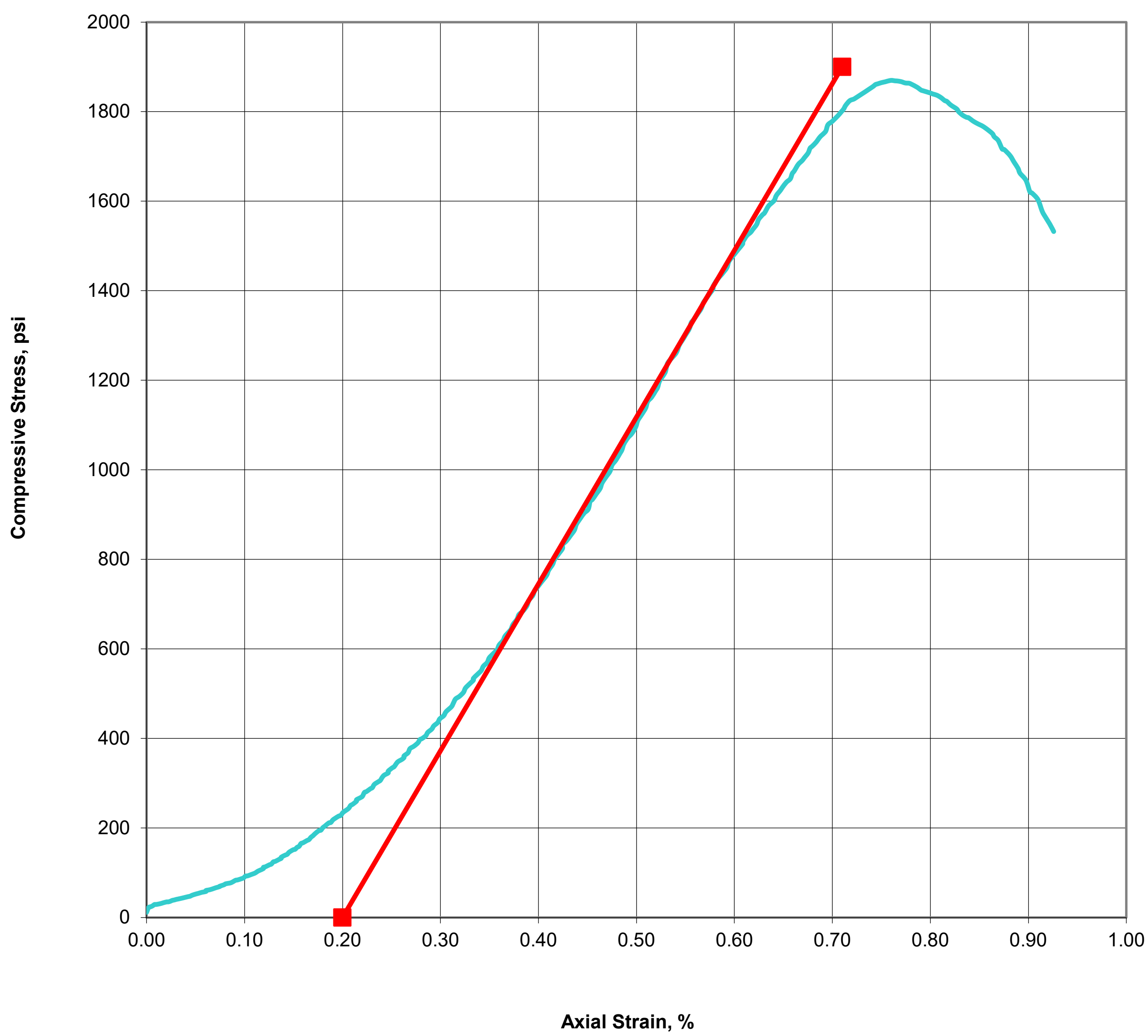
Visual Description: Gray Rock

Moisture Condition at Test: Sample was washed and in a moist state.

Test Temperature, (^{o}C): Ambient

Remarks:

Sample Height, in.	4.95	**Unconfined Compressive Strength (psi)**	**1870**
Sample Diameter, in.	2.40		
Height / Diameter	2.1		
Sample Area, in^2	4.53		
Wet Density, pcf	168.7	**Young's Modulus (E) (psi)**	**372,500**
Dry Density, pcf	164.6		
Moisture Content, %	2.5		
Strain Rate, % / min	0.26		



Boring No.	LB-2	LB-2					
Sample No.	Box 3	B0x 3					
Depth (ft.)	42.5-44.0	45.0-50.0					
Sample Type	Chunk	Chunk					
Visual Soil Classification	Sandstone	Sandstone					
Weight of Sample (g)	546.9	591.6					
Weight of Waxed Sample (g)	551.3	599.5					
Weight of Waxed Sample in Water (g)	334.0	363.0					
Specific Gravity of Wax (g/cm³)	0.89	0.89					
Wet Weight of Soil + Container (g)	276.9	274.5					
Dry Weight of Soil + Container (g)	273.6	269.2					
Weight of Container (g)	77.2	75.9					
Container No.							
Wet Density	160.70	162.18					
Moisture Content (%)	**1.7**	**2.7**					
Dry Density (pcf)	**158.0**	**157.9**					

Leighton

MOISTURE & DENSITY of "UNDISTURBED" CHUNK SAMPLES

Project Name: Fallbrook
Project No.: 12115.001
Tested By: ACS/OHF Date: 03/18/19

Leighton

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name:	Fallbrook	Tested By :	O. Figueroa	Date:	05/01/19
Project No. :	12115.001	Input By:	J. Ward	Date:	05/10/19

Boring No.	LB-1	LB-2		
Sample No.	Composite S1, S2, S3	Core		
Sample Depth (ft)	5, 8.5, 11	25-30		
Soil Identification:	Olive brown SP-SM	Olive brown (SW)g		
Wet Weight of Soil + Container (g)	0.00	186.63		
Dry Weight of Soil + Container (g)	0.00	183.32		
Weight of Container (g)	1.00	36.58		
Moisture Content (%)	0.00	2.26		
Weight of Soaked Soil (g)	100.25	100.50		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	310	94		
Crucible No.	15	3		
Furnace Temperature (°C)	860	860		
Time In / Time Out	9:00/9:45	9:00/9:45		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	25.5593	19.6153		
Wt. of Crucible (g)	25.5563	19.6140		
Wt. of Residue (g) (A)	0.0030	0.0013		
PPM of Sulfate (A) x 41150	123.45	53.50		
PPM of Sulfate, Dry Weight Basis	**123**	**55**		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30	30		
ml of AgNO3 Soln. Used in Titration (C)	0.7	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	50	60		
PPM of Chloride, Dry Wt. Basis	**50**	**61**		

pH TEST, DOT California Test 643

pH Value	**8.11**	**8.20**		
Temperature °C	23.0	22.6		

SOIL RESISTIVITY TEST
DOT CA TEST 643

Leighton

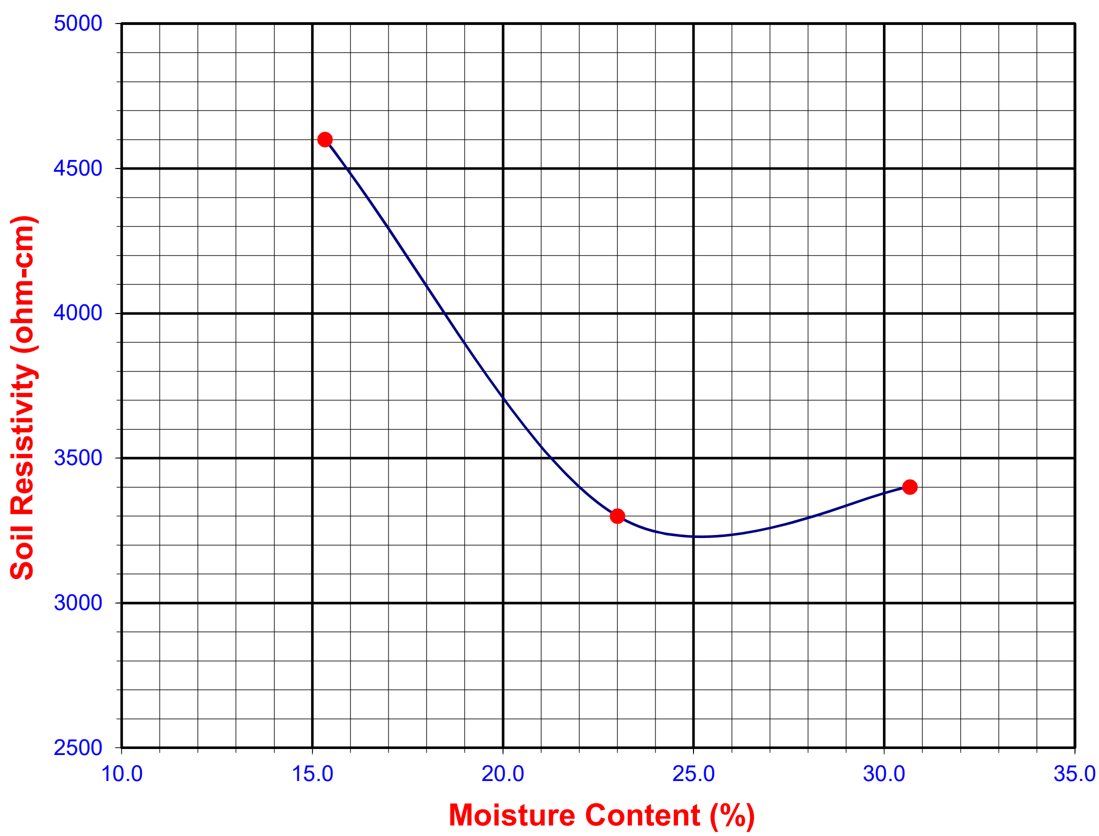
Project Name:	Fallbrook	Tested By :	O. Figueroa Date: 05/07/19
Project No. :	12115.001	Input By:	J. Ward Date: 05/10/19
Boring No.:	LB-1	Depth (ft.) :	5, 8.5, 11
Sample No. :	Composite S1, S2, S3		
Soil Identification:*	Olive brown SP-SM		

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	20	15.34	4600	4600
2	30	23.01	3300	3300
3	40	30.67	3400	3400
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.40
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
3220	**25.2**	**123**	**50**	**8.11**	**23.0**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Project Name:	Fallbrook	Tested By :	O. Figueroa Date: 05/07/19
Project No. :	12115.001	Input By:	J. Ward Date: 05/10/19
Boring No.:	LB-2	Depth (ft.) :	25-30
Sample No. :	Core		

Soil Identification:* Olive brown (SW)g

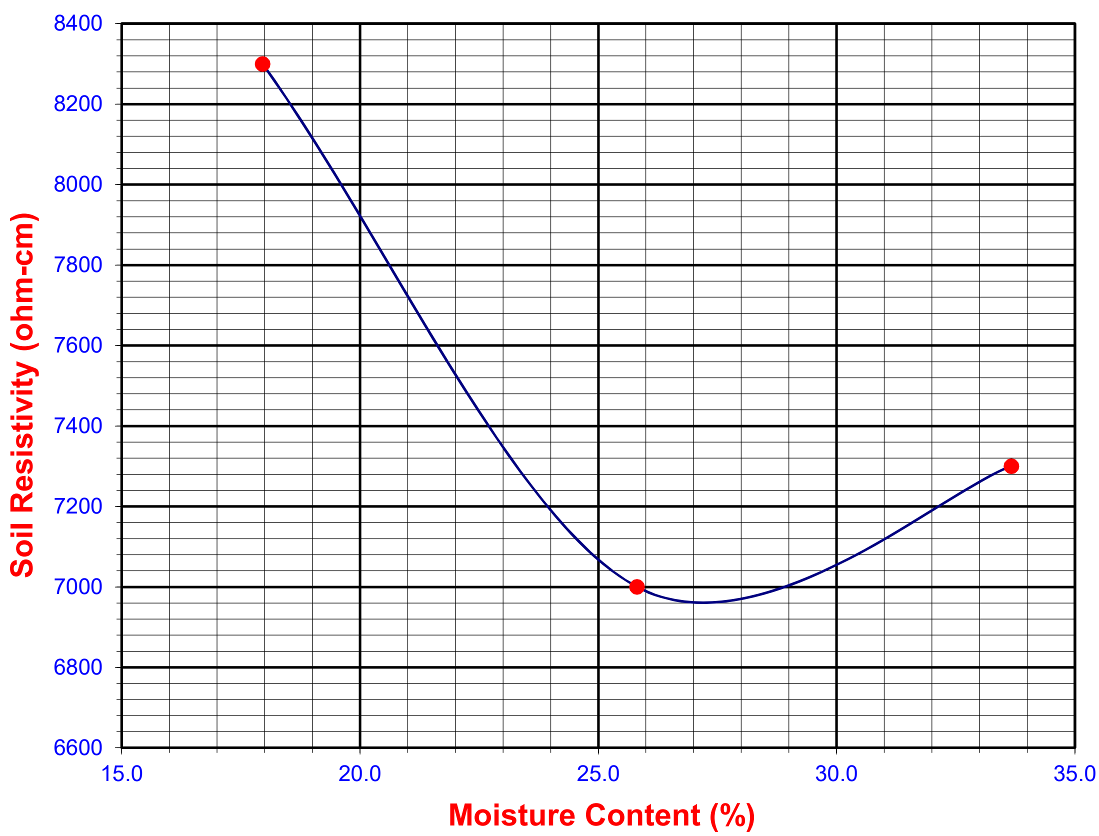
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	20	17.96	8300	8300
2	30	25.81	7000	7000
3	40	33.67	7300	7300
4				
5				

Moisture Content (%) (MCi)	2.26
Wet Wt. of Soil + Cont. (g)	186.63
Dry Wt. of Soil + Cont. (g)	183.32
Wt. of Container (g)	36.58
Container No.	
Initial Soil Wt. (g) (Wt)	130.22
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
6960	**27.2**	**55**	**61**	**8.20**	**22.6**



Leighton

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS

ASTM D 6913

Project Name: Fallbrook
Project No.: 12115.001
Boring No.: LB-1, LB-2
Sample No.: Composite
Soil Identification: Olive brown well-graded sand with silt (SW-SM)

Tested By: G. Bathala Date: 05/13/19
Checked By: J. Ward Date: 05/15/19
Depth (feet): Composite

		Moisture Content of Total Air - Dry Soil	
Container No.:	934	Wt. of Air-Dry Soil + Cont. (g)	0.0
Wt. of Air-Dried Soil + Cont.(g)	983.5	Wt. of Dry Soil + Cont. (g)	0.0
Wt. of Container (g)	108.1	Wt. of Container No.______ (g)	1.0
Dry Wt. of Soil (g)	875.4	Moisture Content (%)	0.0

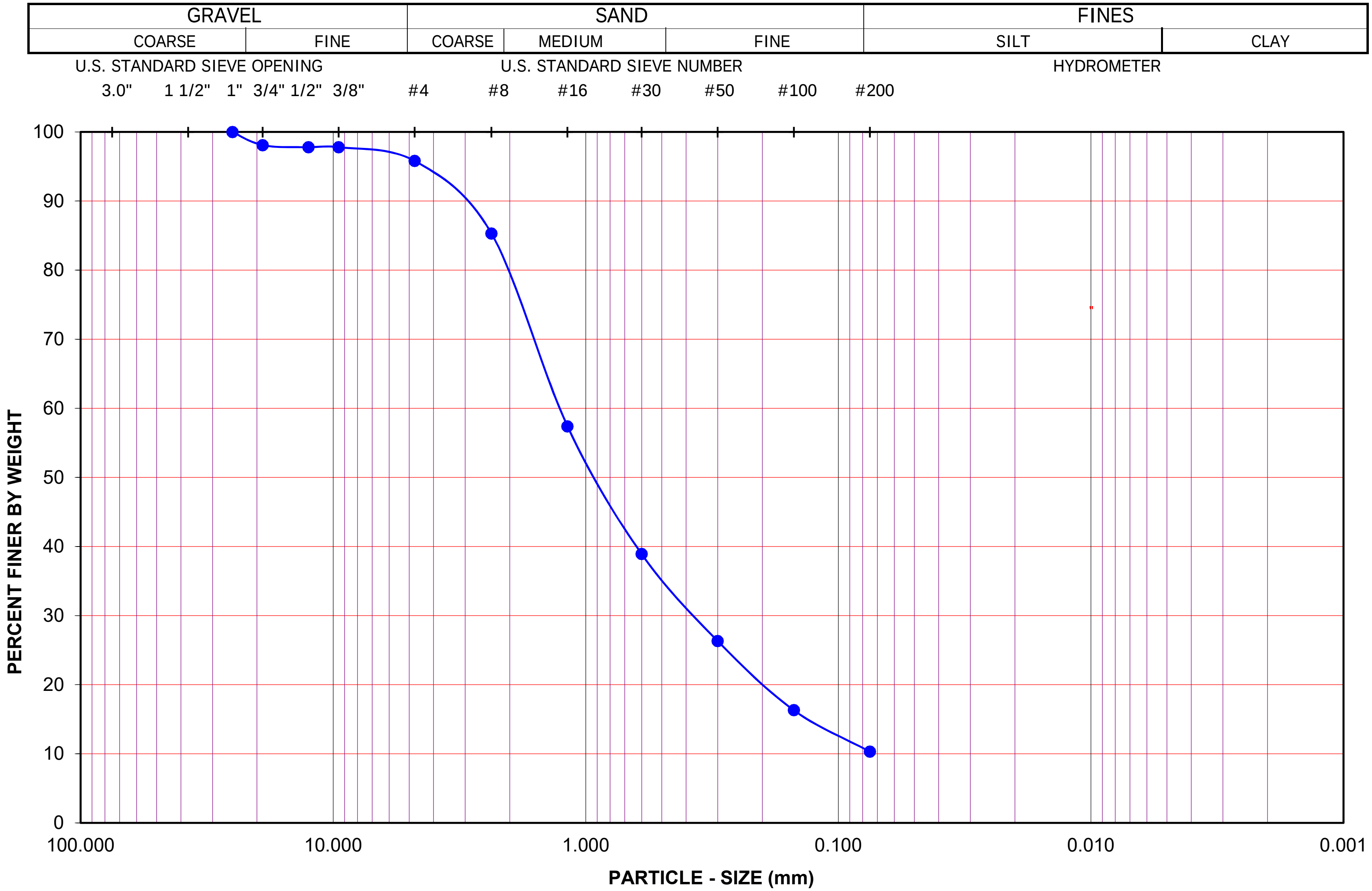
After Wet Sieve	Container No.	934
	Wt. of Dry Soil + Container (g)	896.0
	Wt. of Container (g)	108.1
	Dry Wt. of Soil Retained on # 200 Sieve (g)	787.9

U. S. Sieve Size (in.)	U. S. Sieve Size (mm.)	Cumulative Weight Dry Soil Retained (g)	Percent Passing (%)
1 1/2"	37.5		
1"	25.0	0.0	100.0
3/4"	19.0	16.2	98.1
1/2"	12.5	19.3	97.8
3/8"	9.5	19.3	97.8
#4	4.75	36.7	95.8
#8	2.36	128.4	85.3
#16	1.18	373.0	57.4
#30	0.600	535.2	38.9
#50	0.300	645.3	26.3
#100	0.150	732.7	16.3
#200	0.075	784.8	10.3
PAN			

GRAVEL: **4 %**
SAND: **86 %**
FINES: **10 %**
GROUP SYMBOL: **SW-SM**

Cu = D60/D10 = 18.06
Cc = $(D30)^2/(D60*D10)$ = 1.54

Remarks:



Project Name: Fallbrook

Project No.: 12115.001

Boring No.: LB-1, LB-2 Sample No.: Composite

Depth (feet): Composite Soil Type : SW-SM

Soil Identification: Olive brown well-graded sand with silt (SW-SM)

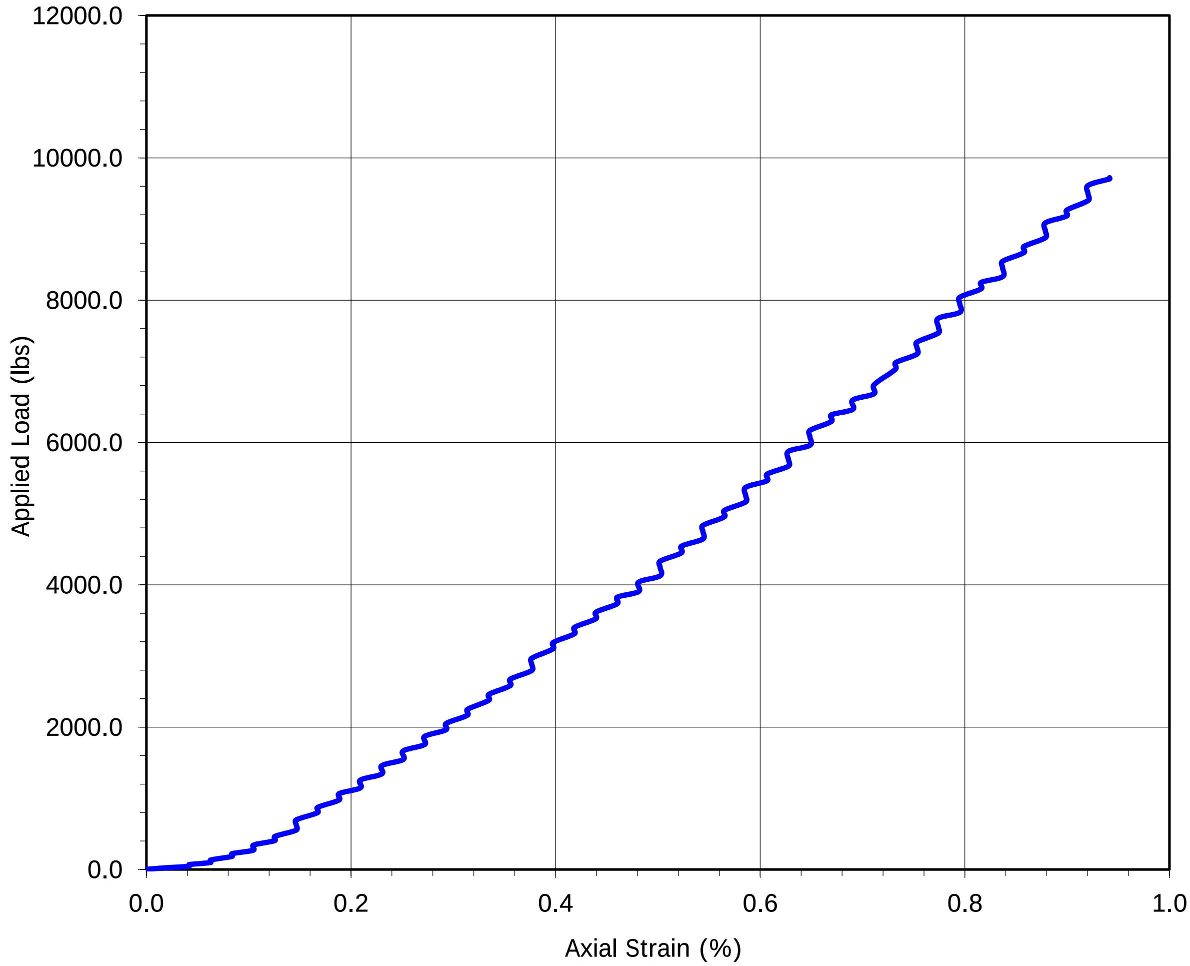
GR:SA:FI : (%) 4 : 86 : 10

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

May-19

SA Composite LB-1, LB-2 (02-22-19)



Boring No.:	LB-3
Sample No.:	Core
Depth (ft):	31.0
Soil Type:	Core
Sample Description:	Rock core

Sample Diameter (in.)	2.400
Sample Height (in.)	4.780
Initial Moisture Content (%)	N/A
Dry Density (pcf)	N/A
Specific Gravity (assumed)	2.70
Saturation (%)	N/A
Rate of Deformation (in/min)	0.0450
Height / Diameter Ratio	1.99

At Failure

Compressive Strength (psi)	**N/A**
Axial Strain (%)	N/A

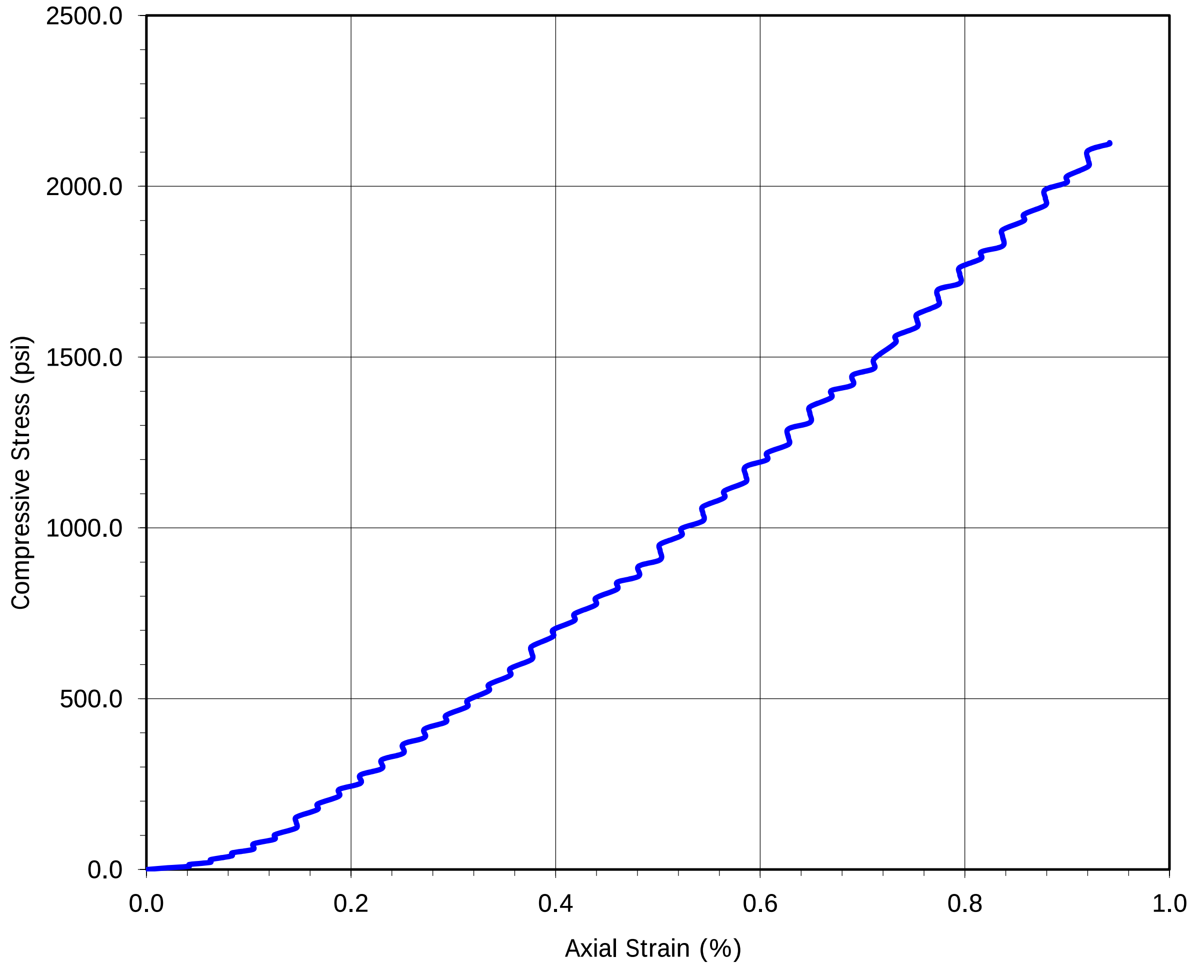
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **12115.001**

Fallbrook

04/08/19



Boring No.:	LB-3
Sample No.:	Core
Depth (ft):	31.0
Soil Type:	Core
Sample Description:	Rock core

Sample Diameter (in.)	2.400
Sample Height (in.)	4.780
Initial Moisture Content (%)	N/A
Dry Density (pcf)	N/A
Specific Gravity (assumed)	2.70
Saturation (%)	N/A
Rate of Deformation (in/min)	0.0450
Height / Diameter Ratio	1.99

At Failure

Compressive Strength (psi)	**N/A**
Axial Strain (%)	N/A

Leighton

Unconfined Compressive Strength
of Cohesive Soil
ASTM D 2166

Project No.: **12115.001**

Fallbrook

04/08/19

Leighton

17781 Cowan
Irvine, CA 92614
Tel. (949) 222-5321
Fax (949) 263-8843

Unconfined Compressive Strength ASTM D2166

Project Name:	Fallbrook	Project No.:	12115.001
Sampled By:	N/A	Sample Date:	N/A

MATERIAL SAMPLE TYPE

Rock X Granite ____ Soil Cement ____ Concrete ____

FOR LAB USE ONLY	**DATE RECEIVED:** N/A	**By:** A. Santos

Laboratory Test Data

Laboratory No.	Age Days	Test Date	Height (in)	Diam. (in)	Area (sq. in.)	Load (lbs.)	Compr. (psi)	H/D Ratio	Corr. Factor	Compr. (psi)	Failure Type
1	N/A	04/08/19	4.78	2.40	4.52	53920	11919	1.99	1.00	11919	3
Remarks:											

Locations: Laboratory No. 1 = sample LB-3, Core @ 31 ft.

Note: Strength exceeded the capacity of the 10,000 lb. load cell on the unconfined compressive strength testing machine for soils. Test was continued using the compressive strength machine for concrete.

APPENDIX D

SEISMIC HAZARD ANALYSIS

Leighton

SITE DATA (ARS Online Version 2.3.09)

Shear Wave Velocity, *Vs30*:	752 m/s
Latitude:	33.414258
Longitude:	-117.241968
Depth to Vs = 1.0 km/s:	N/A
Depth to Vs = 2.5 km/s:	N/A

DETERMINISTIC

Elsinore (Temecula)

Fault ID:	378
Maximum Magnitude (MMax):	7.7
Fault Type:	SS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	14.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	13.08 km
Rjb:	13.08 km
Rx:	13.08 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.263	1.000	1.000	0.263
0.02	0.268	1.000	1.000	0.268
0.022	0.272	1.000	1.000	0.272
0.025	0.278	1.000	1.000	0.278
0.029	0.285	1.000	1.000	0.285
0.03	0.288	1.000	1.000	0.288
0.032	0.294	1.000	1.000	0.294
0.035	0.303	1.000	1.000	0.303
0.036	0.306	1.000	1.000	0.306
0.04	0.319	1.000	1.000	0.319
0.042	0.326	1.000	1.000	0.326
0.044	0.333	1.000	1.000	0.333
0.045	0.336	1.000	1.000	0.336
0.046	0.340	1.000	1.000	0.340
0.048	0.347	1.000	1.000	0.347
0.05	0.353	1.000	1.000	0.353
0.055	0.374	1.000	1.000	0.374
0.06	0.395	1.000	1.000	0.395
0.065	0.414	1.000	1.000	0.414
0.067	0.422	1.000	1.000	0.422
0.07	0.434	1.000	1.000	0.434
0.075	0.453	1.000	1.000	0.453

0.08	0.470	1.000	1.000	0.470
0.085	0.487	1.000	1.000	0.487
0.09	0.503	1.000	1.000	0.503
0.095	0.519	1.000	1.000	0.519
0.1	0.534	1.000	1.000	0.534
0.11	0.557	1.000	1.000	0.557
0.12	0.577	1.000	1.000	0.577
0.13	0.593	1.000	1.000	0.593
0.133	0.597	1.000	1.000	0.597
0.14	0.606	1.000	1.000	0.606
0.15	0.617	1.000	1.000	0.617
0.16	0.620	1.000	1.000	0.620
0.17	0.621	1.000	1.000	0.621
0.18	0.621	1.000	1.000	0.621
0.19	0.619	1.000	1.000	0.619
0.2	0.617	1.000	1.000	0.617
0.22	0.595	1.000	1.000	0.595
0.24	0.573	1.000	1.000	0.573
0.25	0.563	1.000	1.000	0.563
0.26	0.552	1.000	1.000	0.552
0.28	0.532	1.000	1.000	0.532
0.29	0.522	1.000	1.000	0.522
0.3	0.512	1.000	1.000	0.512
0.32	0.495	1.000	1.000	0.495
0.34	0.478	1.000	1.000	0.478
0.35	0.470	1.000	1.000	0.470
0.36	0.462	1.000	1.000	0.462
0.38	0.447	1.000	1.000	0.447
0.4	0.433	1.000	1.000	0.433
0.42	0.420	1.000	1.000	0.420
0.44	0.408	1.000	1.000	0.408
0.45	0.402	1.000	1.000	0.402
0.46	0.397	1.000	1.000	0.397
0.48	0.386	1.000	1.000	0.386
0.5	0.376	1.000	1.000	0.376
0.55	0.349	1.000	1.020	0.356
0.6	0.326	1.000	1.040	0.339
0.65	0.306	1.000	1.060	0.324
0.667	0.300	1.000	1.067	0.320
0.7	0.288	1.000	1.080	0.311
0.75	0.273	1.000	1.100	0.300
0.8	0.260	1.000	1.120	0.291
0.85	0.248	1.000	1.140	0.283
0.9	0.237	1.000	1.160	0.275
0.95	0.227	1.000	1.180	0.268
1	0.218	1.000	1.200	0.262
1.1	0.201	1.000	1.200	0.241
1.2	0.186	1.000	1.200	0.223
1.3	0.173	1.000	1.200	0.207

1.4	0.161	1.000	1.200	0.193
1.5	0.151	1.000	1.200	0.181
1.6	0.141	1.000	1.200	0.169
1.7	0.132	1.000	1.200	0.159
1.8	0.124	1.000	1.200	0.149
1.9	0.117	1.000	1.200	0.141
2	0.111	1.000	1.200	0.133
2.2	0.100	1.000	1.200	0.119
2.4	0.090	1.000	1.200	0.108
2.5	0.086	1.000	1.200	0.103
2.6	0.082	1.000	1.200	0.099
2.8	0.076	1.000	1.200	0.091
3	0.070	1.000	1.200	0.084
3.2	0.065	1.000	1.200	0.078
3.4	0.061	1.000	1.200	0.073
3.5	0.059	1.000	1.200	0.070
3.6	0.057	1.000	1.200	0.068
3.8	0.053	1.000	1.200	0.064
4	0.050	1.000	1.200	0.060
4.2	0.048	1.000	1.200	0.057
4.4	0.046	1.000	1.200	0.055
4.6	0.043	1.000	1.200	0.052
4.8	0.041	1.000	1.200	0.050
5	0.040	1.000	1.200	0.048

Elsinore (Glen Ivy) rev

Fault ID:	365
Maximum Magnitude (MMax):	7.7
Fault Type:	SS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	13.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	23.40 km
Rjb:	23.39 km
Rx:	15.44 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.173	1.000	1.000	0.173
0.02	0.176	1.000	1.000	0.176
0.022	0.178	1.000	1.000	0.178
0.025	0.182	1.000	1.000	0.182
0.029	0.186	1.000	1.000	0.186
0.03	0.188	1.000	1.000	0.188
0.032	0.191	1.000	1.000	0.191
0.035	0.197	1.000	1.000	0.197

0.036	0.199	1.000	1.000	0.199
0.04	0.207	1.000	1.000	0.207
0.042	0.211	1.000	1.000	0.211
0.044	0.215	1.000	1.000	0.215
0.045	0.217	1.000	1.000	0.217
0.046	0.220	1.000	1.000	0.220
0.048	0.224	1.000	1.000	0.224
0.05	0.228	1.000	1.000	0.228
0.055	0.241	1.000	1.000	0.241
0.06	0.254	1.000	1.000	0.254
0.065	0.266	1.000	1.000	0.266
0.067	0.271	1.000	1.000	0.271
0.07	0.278	1.000	1.000	0.278
0.075	0.290	1.000	1.000	0.290
0.08	0.301	1.000	1.000	0.301
0.085	0.311	1.000	1.000	0.311
0.09	0.322	1.000	1.000	0.322
0.095	0.331	1.000	1.000	0.331
0.1	0.341	1.000	1.000	0.341
0.11	0.356	1.000	1.000	0.356
0.12	0.369	1.000	1.000	0.369
0.13	0.380	1.000	1.000	0.380
0.133	0.382	1.000	1.000	0.382
0.14	0.388	1.000	1.000	0.388
0.15	0.395	1.000	1.000	0.395
0.16	0.397	1.000	1.000	0.397
0.17	0.398	1.000	1.000	0.398
0.18	0.398	1.000	1.000	0.398
0.19	0.397	1.000	1.000	0.397
0.2	0.396	1.000	1.000	0.396
0.22	0.382	1.000	1.000	0.382
0.24	0.370	1.000	1.000	0.370
0.25	0.363	1.000	1.000	0.363
0.26	0.357	1.000	1.000	0.357
0.28	0.345	1.000	1.000	0.345
0.29	0.338	1.000	1.000	0.338
0.3	0.333	1.000	1.000	0.333
0.32	0.321	1.000	1.000	0.321
0.34	0.310	1.000	1.000	0.310
0.35	0.305	1.000	1.000	0.305
0.36	0.300	1.000	1.000	0.300
0.38	0.290	1.000	1.000	0.290
0.4	0.281	1.000	1.000	0.281
0.42	0.273	1.000	1.000	0.273
0.44	0.265	1.000	1.000	0.265
0.45	0.262	1.000	1.000	0.262
0.46	0.258	1.000	1.000	0.258
0.48	0.251	1.000	1.000	0.251
0.5	0.245	1.000	1.000	0.245

0.55	0.227	1.000	1.003	0.228
0.6	0.213	1.000	1.006	0.214
0.65	0.200	1.000	1.010	0.202
0.667	0.196	1.000	1.011	0.198
0.7	0.189	1.000	1.013	0.191
0.75	0.179	1.000	1.016	0.182
0.8	0.171	1.000	1.019	0.174
0.85	0.163	1.000	1.022	0.166
0.9	0.156	1.000	1.026	0.160
0.95	0.149	1.000	1.029	0.154
1	0.144	1.000	1.032	0.148
1.1	0.132	1.000	1.032	0.136
1.2	0.122	1.000	1.032	0.126
1.3	0.114	1.000	1.032	0.117
1.4	0.106	1.000	1.032	0.110
1.5	0.099	1.000	1.032	0.103
1.6	0.093	1.000	1.032	0.096
1.7	0.087	1.000	1.032	0.090
1.8	0.082	1.000	1.032	0.085
1.9	0.078	1.000	1.032	0.080
2	0.073	1.000	1.032	0.076
2.2	0.066	1.000	1.032	0.068
2.4	0.060	1.000	1.032	0.062
2.5	0.057	1.000	1.032	0.059
2.6	0.055	1.000	1.032	0.056
2.8	0.050	1.000	1.032	0.052
3	0.046	1.000	1.032	0.048
3.2	0.043	1.000	1.032	0.044
3.4	0.040	1.000	1.032	0.042
3.5	0.039	1.000	1.032	0.040
3.6	0.038	1.000	1.032	0.039
3.8	0.036	1.000	1.032	0.037
4	0.034	1.000	1.032	0.035
4.2	0.032	1.000	1.032	0.033
4.4	0.030	1.000	1.032	0.031
4.6	0.029	1.000	1.032	0.030
4.8	0.028	1.000	1.032	0.028
5	0.026	1.000	1.032	0.027

Elsinore (Julian)

Fault ID:	390
Maximum Magnitude (MMax):	7.7
Fault Type:	SS
Fault Dip:	84 Deg
Dip Direction:	NE
Bottom of Rupture Plane:	18.90 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	23.52 km

Rjb:	23.11 km
Rx:	5.97 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.172	1.000	1.000	0.172
0.02	0.175	1.000	1.000	0.175
0.022	0.178	1.000	1.000	0.178
0.025	0.181	1.000	1.000	0.181
0.029	0.186	1.000	1.000	0.186
0.03	0.187	1.000	1.000	0.187
0.032	0.191	1.000	1.000	0.191
0.035	0.197	1.000	1.000	0.197
0.036	0.199	1.000	1.000	0.199
0.04	0.206	1.000	1.000	0.206
0.042	0.211	1.000	1.000	0.211
0.044	0.215	1.000	1.000	0.215
0.045	0.217	1.000	1.000	0.217
0.046	0.219	1.000	1.000	0.219
0.048	0.223	1.000	1.000	0.223
0.05	0.227	1.000	1.000	0.227
0.055	0.240	1.000	1.000	0.240
0.06	0.253	1.000	1.000	0.253
0.065	0.265	1.000	1.000	0.265
0.067	0.270	1.000	1.000	0.270
0.07	0.277	1.000	1.000	0.277
0.075	0.289	1.000	1.000	0.289
0.08	0.300	1.000	1.000	0.300
0.085	0.310	1.000	1.000	0.310
0.09	0.321	1.000	1.000	0.321
0.095	0.330	1.000	1.000	0.330
0.1	0.340	1.000	1.000	0.340
0.11	0.355	1.000	1.000	0.355
0.12	0.368	1.000	1.000	0.368
0.13	0.378	1.000	1.000	0.378
0.133	0.381	1.000	1.000	0.381
0.14	0.387	1.000	1.000	0.387
0.15	0.394	1.000	1.000	0.394
0.16	0.396	1.000	1.000	0.396
0.17	0.397	1.000	1.000	0.397
0.18	0.397	1.000	1.000	0.397
0.19	0.396	1.000	1.000	0.396
0.2	0.395	1.000	1.000	0.395
0.22	0.381	1.000	1.000	0.381
0.24	0.368	1.000	1.000	0.368
0.25	0.362	1.000	1.000	0.362
0.26	0.355	1.000	1.000	0.355

0.28	0.343	1.000	1.000	0.343
0.29	0.337	1.000	1.000	0.337
0.3	0.332	1.000	1.000	0.332
0.32	0.320	1.000	1.000	0.320
0.34	0.309	1.000	1.000	0.309
0.35	0.304	1.000	1.000	0.304
0.36	0.299	1.000	1.000	0.299
0.38	0.289	1.000	1.000	0.289
0.4	0.280	1.000	1.000	0.280
0.42	0.272	1.000	1.000	0.272
0.44	0.264	1.000	1.000	0.264
0.45	0.261	1.000	1.000	0.261
0.46	0.257	1.000	1.000	0.257
0.48	0.250	1.000	1.000	0.250
0.5	0.244	1.000	1.000	0.244
0.55	0.227	1.000	1.003	0.227
0.6	0.212	1.000	1.006	0.213
0.65	0.199	1.000	1.009	0.201
0.667	0.195	1.000	1.010	0.197
0.7	0.188	1.000	1.012	0.191
0.75	0.179	1.000	1.015	0.181
0.8	0.170	1.000	1.018	0.173
0.85	0.162	1.000	1.021	0.166
0.9	0.155	1.000	1.024	0.159
0.95	0.149	1.000	1.027	0.153
1	0.143	1.000	1.030	0.147
1.1	0.132	1.000	1.030	0.136
1.2	0.122	1.000	1.030	0.126
1.3	0.114	1.000	1.030	0.117
1.4	0.106	1.000	1.030	0.109
1.5	0.099	1.000	1.030	0.102
1.6	0.093	1.000	1.030	0.096
1.7	0.087	1.000	1.030	0.090
1.8	0.082	1.000	1.030	0.084
1.9	0.077	1.000	1.030	0.080
2	0.073	1.000	1.030	0.075
2.2	0.066	1.000	1.030	0.068
2.4	0.060	1.000	1.030	0.061
2.5	0.057	1.000	1.030	0.058
2.6	0.054	1.000	1.030	0.056
2.8	0.050	1.000	1.030	0.051
3	0.046	1.000	1.030	0.048
3.2	0.043	1.000	1.030	0.044
3.4	0.040	1.000	1.030	0.041
3.5	0.039	1.000	1.030	0.040
3.6	0.038	1.000	1.030	0.039
3.8	0.035	1.000	1.030	0.036
4	0.033	1.000	1.030	0.034
4.2	0.032	1.000	1.030	0.033

4.4	0.030	1.000	1.030	0.031
4.6	0.029	1.000	1.030	0.030
4.8	0.027	1.000	1.030	0.028
5	0.026	1.000	1.030	0.027

San Jacinto (Anza)

Fault ID:	362
Maximum Magnitude (MMax):	7.7
Fault Type:	SS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	17.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	46.43 km
Rjb:	46.42 km
Rx:	46.43 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.098	1.000	1.000	0.098
0.02	0.099	1.000	1.000	0.099
0.022	0.101	1.000	1.000	0.101
0.025	0.102	1.000	1.000	0.102
0.029	0.105	1.000	1.000	0.105
0.03	0.105	1.000	1.000	0.105
0.032	0.107	1.000	1.000	0.107
0.035	0.110	1.000	1.000	0.110
0.036	0.111	1.000	1.000	0.111
0.04	0.115	1.000	1.000	0.115
0.042	0.117	1.000	1.000	0.117
0.044	0.119	1.000	1.000	0.119
0.045	0.120	1.000	1.000	0.120
0.046	0.121	1.000	1.000	0.121
0.048	0.123	1.000	1.000	0.123
0.05	0.125	1.000	1.000	0.125
0.055	0.131	1.000	1.000	0.131
0.06	0.138	1.000	1.000	0.138
0.065	0.144	1.000	1.000	0.144
0.067	0.146	1.000	1.000	0.146
0.07	0.149	1.000	1.000	0.149
0.075	0.155	1.000	1.000	0.155
0.08	0.161	1.000	1.000	0.161
0.085	0.166	1.000	1.000	0.166
0.09	0.171	1.000	1.000	0.171
0.095	0.176	1.000	1.000	0.176
0.1	0.180	1.000	1.000	0.180
0.11	0.189	1.000	1.000	0.189

0.12	0.196	1.000	1.000	0.196
0.13	0.202	1.000	1.000	0.202
0.133	0.203	1.000	1.000	0.203
0.14	0.207	1.000	1.000	0.207
0.15	0.211	1.000	1.000	0.211
0.16	0.213	1.000	1.000	0.213
0.17	0.214	1.000	1.000	0.214
0.18	0.215	1.000	1.000	0.215
0.19	0.215	1.000	1.000	0.215
0.2	0.216	1.000	1.000	0.216
0.22	0.210	1.000	1.000	0.210
0.24	0.205	1.000	1.000	0.205
0.25	0.202	1.000	1.000	0.202
0.26	0.199	1.000	1.000	0.199
0.28	0.194	1.000	1.000	0.194
0.29	0.191	1.000	1.000	0.191
0.3	0.188	1.000	1.000	0.188
0.32	0.182	1.000	1.000	0.182
0.34	0.176	1.000	1.000	0.176
0.35	0.174	1.000	1.000	0.174
0.36	0.171	1.000	1.000	0.171
0.38	0.166	1.000	1.000	0.166
0.4	0.161	1.000	1.000	0.161
0.42	0.157	1.000	1.000	0.157
0.44	0.153	1.000	1.000	0.153
0.45	0.151	1.000	1.000	0.151
0.46	0.149	1.000	1.000	0.149
0.48	0.145	1.000	1.000	0.145
0.5	0.142	1.000	1.000	0.142
0.55	0.132	1.000	1.000	0.132
0.6	0.124	1.000	1.000	0.124
0.65	0.117	1.000	1.000	0.117
0.667	0.115	1.000	1.000	0.115
0.7	0.111	1.000	1.000	0.111
0.75	0.106	1.000	1.000	0.106
0.8	0.101	1.000	1.000	0.101
0.85	0.097	1.000	1.000	0.097
0.9	0.092	1.000	1.000	0.092
0.95	0.089	1.000	1.000	0.089
1	0.085	1.000	1.000	0.085
1.1	0.079	1.000	1.000	0.079
1.2	0.073	1.000	1.000	0.073
1.3	0.068	1.000	1.000	0.068
1.4	0.064	1.000	1.000	0.064
1.5	0.060	1.000	1.000	0.060
1.6	0.056	1.000	1.000	0.056
1.7	0.052	1.000	1.000	0.052
1.8	0.049	1.000	1.000	0.049
1.9	0.047	1.000	1.000	0.047

2	0.044	1.000	1.000	0.044
2.2	0.040	1.000	1.000	0.040
2.4	0.036	1.000	1.000	0.036
2.5	0.034	1.000	1.000	0.034
2.6	0.033	1.000	1.000	0.033
2.8	0.030	1.000	1.000	0.030
3	0.028	1.000	1.000	0.028
3.2	0.026	1.000	1.000	0.026
3.4	0.024	1.000	1.000	0.024
3.5	0.024	1.000	1.000	0.024
3.6	0.023	1.000	1.000	0.023
3.8	0.022	1.000	1.000	0.022
4	0.020	1.000	1.000	0.020
4.2	0.019	1.000	1.000	0.019
4.4	0.018	1.000	1.000	0.018
4.6	0.018	1.000	1.000	0.018
4.8	0.017	1.000	1.000	0.017
5	0.016	1.000	1.000	0.016

San Jacinto (San Jacinto Valley-Southern Ext.)

Fault ID:	417
Maximum Magnitude (MMax):	7.7
Fault Type:	SS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	16.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	48.98 km
Rjb:	48.98 km
Rx:	40.93 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.094	1.000	1.000	0.094
0.02	0.095	1.000	1.000	0.095
0.022	0.096	1.000	1.000	0.096
0.025	0.098	1.000	1.000	0.098
0.029	0.100	1.000	1.000	0.100
0.03	0.100	1.000	1.000	0.100
0.032	0.102	1.000	1.000	0.102
0.035	0.105	1.000	1.000	0.105
0.036	0.106	1.000	1.000	0.106
0.04	0.109	1.000	1.000	0.109
0.042	0.111	1.000	1.000	0.111
0.044	0.113	1.000	1.000	0.113
0.045	0.114	1.000	1.000	0.114
0.046	0.115	1.000	1.000	0.115

0.048	0.117	1.000	1.000	0.117
0.05	0.119	1.000	1.000	0.119
0.055	0.125	1.000	1.000	0.125
0.06	0.131	1.000	1.000	0.131
0.065	0.137	1.000	1.000	0.137
0.067	0.139	1.000	1.000	0.139
0.07	0.142	1.000	1.000	0.142
0.075	0.147	1.000	1.000	0.147
0.08	0.152	1.000	1.000	0.152
0.085	0.157	1.000	1.000	0.157
0.09	0.162	1.000	1.000	0.162
0.095	0.167	1.000	1.000	0.167
0.1	0.171	1.000	1.000	0.171
0.11	0.179	1.000	1.000	0.179
0.12	0.186	1.000	1.000	0.186
0.13	0.192	1.000	1.000	0.192
0.133	0.193	1.000	1.000	0.193
0.14	0.196	1.000	1.000	0.196
0.15	0.200	1.000	1.000	0.200
0.16	0.202	1.000	1.000	0.202
0.17	0.204	1.000	1.000	0.204
0.18	0.205	1.000	1.000	0.205
0.19	0.205	1.000	1.000	0.205
0.2	0.205	1.000	1.000	0.205
0.22	0.200	1.000	1.000	0.200
0.24	0.195	1.000	1.000	0.195
0.25	0.193	1.000	1.000	0.193
0.26	0.190	1.000	1.000	0.190
0.28	0.185	1.000	1.000	0.185
0.29	0.182	1.000	1.000	0.182
0.3	0.180	1.000	1.000	0.180
0.32	0.174	1.000	1.000	0.174
0.34	0.169	1.000	1.000	0.169
0.35	0.166	1.000	1.000	0.166
0.36	0.163	1.000	1.000	0.163
0.38	0.159	1.000	1.000	0.159
0.4	0.154	1.000	1.000	0.154
0.42	0.150	1.000	1.000	0.150
0.44	0.146	1.000	1.000	0.146
0.45	0.144	1.000	1.000	0.144
0.46	0.143	1.000	1.000	0.143
0.48	0.139	1.000	1.000	0.139
0.5	0.136	1.000	1.000	0.136
0.55	0.127	1.000	1.000	0.127
0.6	0.119	1.000	1.000	0.119
0.65	0.113	1.000	1.000	0.113
0.667	0.111	1.000	1.000	0.111
0.7	0.107	1.000	1.000	0.107
0.75	0.102	1.000	1.000	0.102

0.8	0.097	1.000	1.000	0.097
0.85	0.093	1.000	1.000	0.093
0.9	0.089	1.000	1.000	0.089
0.95	0.085	1.000	1.000	0.085
1	0.082	1.000	1.000	0.082
1.1	0.076	1.000	1.000	0.076
1.2	0.070	1.000	1.000	0.070
1.3	0.065	1.000	1.000	0.065
1.4	0.061	1.000	1.000	0.061
1.5	0.057	1.000	1.000	0.057
1.6	0.054	1.000	1.000	0.054
1.7	0.050	1.000	1.000	0.050
1.8	0.048	1.000	1.000	0.048
1.9	0.045	1.000	1.000	0.045
2	0.043	1.000	1.000	0.043
2.2	0.038	1.000	1.000	0.038
2.4	0.035	1.000	1.000	0.035
2.5	0.033	1.000	1.000	0.033
2.6	0.032	1.000	1.000	0.032
2.8	0.029	1.000	1.000	0.029
3	0.027	1.000	1.000	0.027
3.2	0.025	1.000	1.000	0.025
3.4	0.024	1.000	1.000	0.024
3.5	0.023	1.000	1.000	0.023
3.6	0.022	1.000	1.000	0.022
3.8	0.021	1.000	1.000	0.021
4	0.020	1.000	1.000	0.020
4.2	0.019	1.000	1.000	0.019
4.4	0.018	1.000	1.000	0.018
4.6	0.017	1.000	1.000	0.017
4.8	0.016	1.000	1.000	0.016
5	0.015	1.000	1.000	0.015

PROBABILISTIC

Probabilistic Model
USGS Seismic Hazard Map(2008) 975 Year Return Period

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor(Applied)	SA(Final Spectrum)
0.01	0.352	1.000	1.000	0.352
0.02	0.437	1.000	1.000	0.437
0.022	0.450	1.000	1.000	0.450
0.025	0.468	1.000	1.000	0.468
0.029	0.490	1.000	1.000	0.490
0.03	0.495	1.000	1.000	0.495
0.032	0.505	1.000	1.000	0.505
0.035	0.520	1.000	1.000	0.520
0.036	0.524	1.000	1.000	0.524

0.04	0.542	1.000	1.000	0.542
0.042	0.550	1.000	1.000	0.550
0.044	0.558	1.000	1.000	0.558
0.045	0.562	1.000	1.000	0.562
0.046	0.566	1.000	1.000	0.566
0.048	0.573	1.000	1.000	0.573
0.05	0.581	1.000	1.000	0.581
0.055	0.598	1.000	1.000	0.598
0.06	0.614	1.000	1.000	0.614
0.065	0.630	1.000	1.000	0.630
0.067	0.636	1.000	1.000	0.636
0.07	0.645	1.000	1.000	0.645
0.075	0.659	1.000	1.000	0.659
0.08	0.672	1.000	1.000	0.672
0.085	0.685	1.000	1.000	0.685
0.09	0.697	1.000	1.000	0.697
0.095	0.709	1.000	1.000	0.709
0.1	0.720	1.000	1.000	0.720
0.11	0.735	1.000	1.000	0.735
0.12	0.748	1.000	1.000	0.748
0.13	0.761	1.000	1.000	0.761
0.133	0.765	1.000	1.000	0.765
0.14	0.773	1.000	1.000	0.773
0.15	0.784	1.000	1.000	0.784
0.16	0.795	1.000	1.000	0.795
0.17	0.805	1.000	1.000	0.805
0.18	0.815	1.000	1.000	0.815
0.19	0.824	1.000	1.000	0.824
0.2	0.833	1.000	1.000	0.833
0.22	0.796	1.000	1.000	0.796
0.24	0.764	1.000	1.000	0.764
0.25	0.750	1.000	1.000	0.750
0.26	0.736	1.000	1.000	0.736
0.28	0.711	1.000	1.000	0.711
0.29	0.699	1.000	1.000	0.699
0.3	0.688	1.000	1.000	0.688
0.32	0.659	1.000	1.000	0.659
0.34	0.632	1.000	1.000	0.632
0.35	0.620	1.000	1.000	0.620
0.36	0.608	1.000	1.000	0.608
0.38	0.586	1.000	1.000	0.586
0.4	0.566	1.000	1.000	0.566
0.42	0.547	1.000	1.000	0.547
0.44	0.530	1.000	1.000	0.530
0.45	0.522	1.000	1.000	0.522
0.46	0.515	1.000	1.000	0.515
0.48	0.500	1.000	1.000	0.500
0.5	0.486	1.000	1.000	0.486
0.55	0.449	1.000	1.020	0.458

0.6	0.418	1.000	1.040	0.435
0.65	0.392	1.000	1.060	0.415
0.667	0.383	1.000	1.067	0.409
0.7	0.368	1.000	1.080	0.398
0.75	0.348	1.000	1.100	0.383
0.8	0.329	1.000	1.120	0.368
0.85	0.312	1.000	1.140	0.356
0.9	0.297	1.000	1.160	0.344
0.95	0.283	1.000	1.180	0.334
1	0.271	1.000	1.200	0.325
1.1	0.247	1.000	1.200	0.297
1.2	0.227	1.000	1.200	0.273
1.3	0.211	1.000	1.200	0.253
1.4	0.196	1.000	1.200	0.235
1.5	0.183	1.000	1.200	0.220
1.6	0.172	1.000	1.200	0.207
1.7	0.163	1.000	1.200	0.195
1.8	0.154	1.000	1.200	0.185
1.9	0.146	1.000	1.200	0.175
2	0.139	1.000	1.200	0.167
2.2	0.125	1.000	1.200	0.150
2.4	0.114	1.000	1.200	0.136
2.5	0.109	1.000	1.200	0.130
2.6	0.104	1.000	1.200	0.125
2.8	0.096	1.000	1.200	0.115
3	0.089	1.000	1.200	0.106
3.2	0.082	1.000	1.200	0.099
3.4	0.077	1.000	1.200	0.092
3.5	0.074	1.000	1.200	0.089
3.6	0.072	1.000	1.200	0.086
3.8	0.067	1.000	1.200	0.081
4	0.063	1.000	1.200	0.076
4.2	0.061	1.000	1.200	0.073
4.4	0.059	1.000	1.200	0.070
4.6	0.057	1.000	1.200	0.068
4.8	0.055	1.000	1.200	0.066
5	0.053	1.000	1.200	0.063

MINIMUM DETERMINISTIC SPECTRUM

Period	**SA**
0.01	0.197
0.02	0.201
0.022	0.204
0.025	0.208
0.029	0.214
0.03	0.216

0.032	0.221
0.035	0.228
0.036	0.231
0.04	0.241
0.042	0.246
0.044	0.251
0.045	0.254
0.046	0.256
0.048	0.262
0.05	0.267
0.055	0.284
0.06	0.300
0.065	0.317
0.067	0.323
0.07	0.333
0.075	0.348
0.08	0.362
0.085	0.376
0.09	0.389
0.095	0.402
0.1	0.414
0.11	0.431
0.12	0.445
0.13	0.458
0.133	0.461
0.14	0.468
0.15	0.476
0.16	0.476
0.17	0.475
0.18	0.474
0.19	0.471
0.2	0.468
0.22	0.446
0.24	0.426
0.25	0.416
0.26	0.406
0.28	0.388
0.29	0.380
0.3	0.372
0.32	0.357
0.34	0.343
0.35	0.336
0.36	0.330
0.38	0.318
0.4	0.306
0.42	0.293
0.44	0.281
0.45	0.275
0.46	0.270

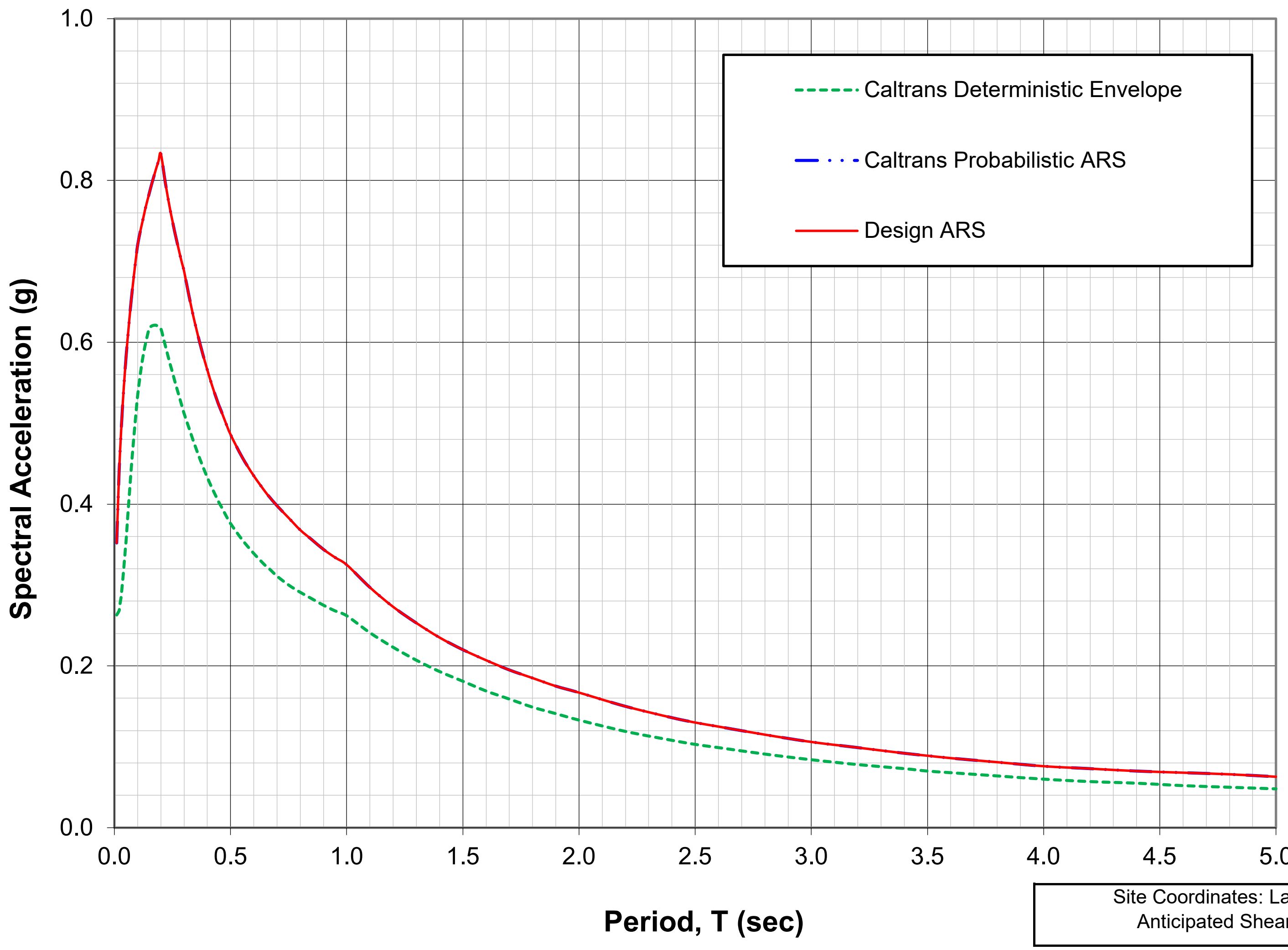
0.48	0.260
0.5	0.250
0.55	0.225
0.6	0.205
0.65	0.187
0.667	0.182
0.7	0.173
0.75	0.160
0.8	0.149
0.85	0.140
0.9	0.131
0.95	0.123
1	0.117
1.1	0.104
1.2	0.093
1.3	0.084
1.4	0.077
1.5	0.070
1.6	0.064
1.7	0.059
1.8	0.055
1.9	0.051
2	0.047
2.2	0.042
2.4	0.037
2.5	0.035
2.6	0.033
2.8	0.030
3	0.027
3.2	0.025
3.4	0.023
3.5	0.022
3.6	0.021
3.8	0.020
4	0.018
4.2	0.017
4.4	0.016
4.6	0.015
4.8	0.015
5	0.014

Envelope Data

Period	SA
0.01	0.352
0.02	0.437
0.022	0.450
0.025	0.468
0.029	0.490

0.03	0.495
0.032	0.505
0.035	0.520
0.036	0.524
0.04	0.542
0.042	0.550
0.044	0.558
0.045	0.562
0.046	0.566
0.048	0.573
0.05	0.581
0.055	0.598
0.06	0.614
0.065	0.630
0.067	0.636
0.07	0.645
0.075	0.659
0.08	0.672
0.085	0.685
0.09	0.697
0.095	0.709
0.1	0.720
0.11	0.735
0.12	0.748
0.13	0.761
0.133	0.765
0.14	0.773
0.15	0.784
0.16	0.795
0.17	0.805
0.18	0.815
0.19	0.824
0.2	0.833
0.22	0.796
0.24	0.764
0.25	0.750
0.26	0.736
0.28	0.711
0.29	0.699
0.3	0.688
0.32	0.659
0.34	0.632
0.35	0.620
0.36	0.608
0.38	0.586
0.4	0.566
0.42	0.547
0.44	0.530
0.45	0.522

0.46	0.515
0.48	0.500
0.5	0.486
0.55	0.458
0.6	0.435
0.65	0.415
0.667	0.409
0.7	0.398
0.75	0.383
0.8	0.368
0.85	0.356
0.9	0.344
0.95	0.334
1	0.325
1.1	0.297
1.2	0.273
1.3	0.253
1.4	0.235
1.5	0.220
1.6	0.207
1.7	0.195
1.8	0.185
1.9	0.175
2	0.167
2.2	0.150
2.4	0.136
2.5	0.130
2.6	0.125
2.8	0.115
3	0.106
3.2	0.099
3.4	0.092
3.5	0.089
3.6	0.086
3.8	0.081
4	0.076
4.2	0.073
4.4	0.070
4.6	0.068
4.8	0.066
5	0.063



Period	Sa
(sec)	(g)
0.01	0.352
0.05	0.581
0.10	0.720
0.15	0.784
0.20	0.833
0.25	0.750
0.30	0.688
0.35	0.620
0.40	0.566
0.45	0.522
0.50	0.486
0.60	0.435
0.70	0.398
0.80	0.368
0.90	0.344
1.00	0.325
1.50	0.220
2.00	0.167
2.50	0.130
3.00	0.106
3.50	0.089
4.00	0.076
4.40	0.070
5.00	0.063

Site Coordinates: Latitude: 33.414258; Longitude: -117.241968
Anticipated Shear Wave Velocity-Vs_{30} (meters/sec) = 752

CALTRANS ARS CURVES
SANDIA CREEK ROAD BRIDGE REPLACEMENT
COUNTY OF SAN DIEGO, CALIFORNIA

Project Name:	Sandia Creek Road Bridge Replacement
Project No.:	12115.001
Designed/Checked by:	JAT/VPI
Date:	May 13, 2019

APPENDIX E

LIQUEFACTION ANALYSIS

Leighton

Leighton

Borehole No	LB-3	
Ground Elevation (NAVD 88)	355.00	ft
Water Depth (Exploration)	25.00	ft
Water Depth (Design)	25.00	ft

A_{max}	0.35	g
M_w	6.77	
MSF	1.30	Triggering
MSF_{Vol}	0.85	Settlement

Energy Ratio	82	%
Settlement FS <=	1.0	
Finished Grade El.	355.00	ft
	User Input	

Borehole diameter (mm)	Correction C_B
115	1
150	1.05
200	1.15

Bedrock
314.2

						Soil Parameters			Soil Stress			Demand		Bore Hole			Blow Counts (N)		Blow Count Correction Factors				Cyclic Resistance									Demand	Results
Elevation	SPT Depth	CPT Corrected Depth	Thickness	Design Depth	Design Depth	γ	Soil Type	FC	σ_{v0}	u	σ_{v0}'	$\sigma_{v0}'_{design}$	r_d	Diameter	Diameter	Sampler	Uncorrected	Sampler Corrected	C_E	C_B	C_R	C_S	N_{60}	C_N	$(N_1)_{60}$	α	β	$(N_1)_{60,CS}$	$CRR_{7.5}$	K_σ	CRR	CSR	FS
ft	ft	ft	ft	ft	m	pcf		%	psf	psf	psf	psf		in	mm																		
332	23.3	23.3	27.7	23	7.1	125	SW-SM	10	2,913	0	2,913	2,913	0.95	4.0	200	SPT	50	50	1.37	1.15	0.95	1.20	90	0.9	76	0.87	1.02	79	too dense	0.92	too dense	0.22	N.A.
323	32.05	32.1	8.6	32	9.8	133	SW-SM	10	4,076	440	3,636	3,530	0.91	8.0	200	SPT	10.5	11	1.37	1.00	0.95	1.20	16	0.8	12	0.87	1.02	14	0.15	0.87	0.17	0.24	0.70
315	40.5	40.5	6.5	41	12.3	133	SW	5	5,200	967	4,233	4,127	0.85	8.0	200	SPT	100	100	1.37	1.15	1.00	1.20	100	0.7	100	0.00	1.00	100	too dense	0.84	too dense	0.24	N.A.

Earthquake Induced Settlement Calculations
Commerce Center Bridge LHS-1 (North Abutment)

Earthquake Magnitude, Mw	6.77
Amax	0.35

N_c 9.12

Groundwater Depth Field	25.00
Design Groundwater	25.00

					Pradel's Unsaturated Settlement Calculations (1998)						Idriss and Boulanger Saturated Calculation (2008)							
Elev	Depth	Layer Thickness, T_i (feet)	Soil Type	FC (%)	Average Shear Stress, τ_{av} (psf)	a	b	Strain, Y (%)	ε_{15}	ε_{Nc}	Limiting Shear Strain, γ_{lim}	F_α	Maximum Shear Strain, γ_{max}	ΔLD_i	Vertical Strain ε_v	Δsi Dry	Δsi Sat	Δ_{total}
332	23.3	0.00	SW-SM	10	188.96	0.18	0.00	5.2E+00	0.01	0.01	-	0.00	0.000	0.00	0.000	0.00	0.00	3.23
323	32.05	8.75	SW-SM	10	218.03	0.20	0.00	-	-	-	0.319	0.81	0.319	33.53	0.031	0.00	3.23	0.00
315	40.5	8.45	SW	5	228.76	0.22	0.00	-	-	-	0.000	-6.07	0.000	0.00	0.000	0.00	0.00	0.00

Project: Sandia Creek Drive Bridge Replacement

Project No.: 12115.001 **Date:** 12-11-19

By: vpi **Checked By:**

Title : Lateral Spread Displacement

"Refernce : Caltrans Memo to Designers 20–15 May 2017"

Pier 2

Yeild Acceleration (g) $k_y := 0.015$

Peak Ground Acceleration (g) $PGA := 0.35$

Earthquake Magnitude $M_w := 6.7$

Rigid Body Displacement

$$D := \exp\left(-0.22 - 2.83\ \ln(k_y) - 0.333\ \ln(k_y)^2 + 0.566\ \ln(k_y) \cdot \ln(PGA) + 3.04\ \ln(PGA) - 0.244\ \ln(PGA)^2 + 0.278\ (M_w - 7)\right)\ cm$$

$$D = 45.213\ in$$

Pier 3

Yeild Acceleration (g) $k_y := 0.04$

Peak Ground Acceleration (g) $PGA := 0.35$

Earthquake Magnitude $M_w := 6.7$

Rigid Body Displacement

$$D := \exp\left(-0.22 - 2.83 \ln\left(k_y\right) - 0.333 \ln\left(k_y\right)^2 + 0.566 \ln\left(k_y\right) \cdot \ln\left(PGA\right) + 3.04 \ln\left(PGA\right) - 0.244 \ln\left(PGA\right)^2 + 0.278 \left(M_w - 7\right)\right) \; cm$$

$$D = 17.741 \; in$$

Pier 4

Yeild Acceleration (g) $k_y := 0.115$

Peak Ground Acceleration (g) $PGA := 0.35$

Earthquake Magnitude $M_w := 6.7$

Rigid Body Displacement

$$D := \exp\left(-0.22 - 2.83 \ln\left(k_y\right) - 0.333 \ln\left(k_y\right)^2 + 0.566 \ln\left(k_y\right) \cdot \ln\left(PGA\right) + 3.04 \ln\left(PGA\right) - 0.244 \ln\left(PGA\right)^2 + 0.278 \left(M_w - 7\right)\right) \; cm$$

$$D = 3.165 \; in$$

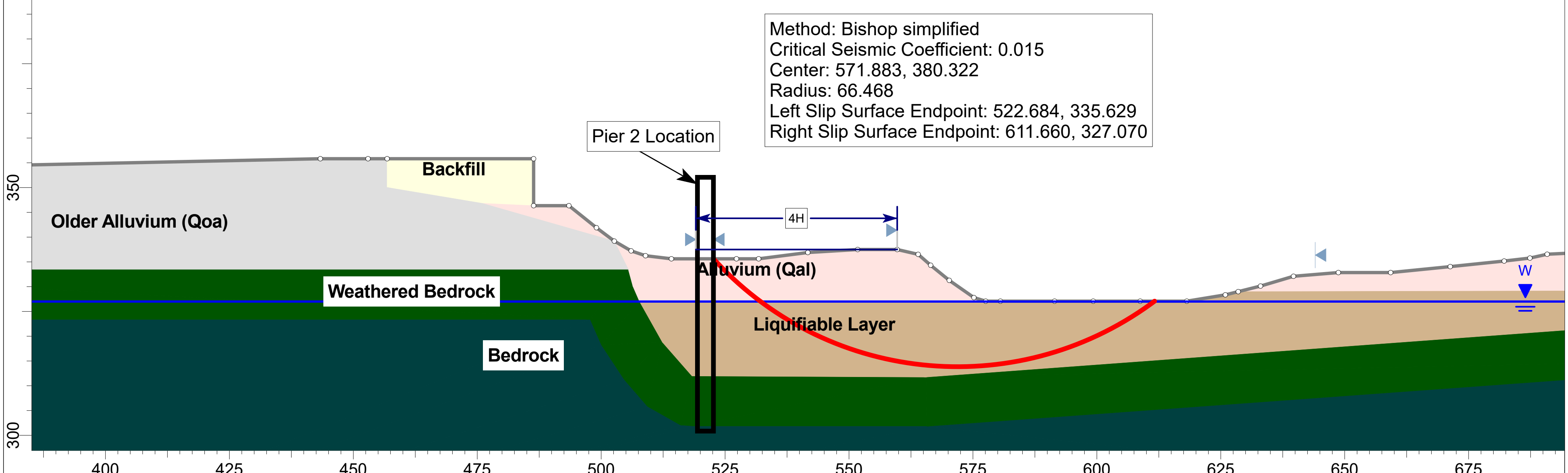
"END"

Sandia Creek Drive Bridge Replacement

Lateral Spread Potential

\\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Slide\New Proposed Bridge\12115 Sandia Creek Drive Bridge.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu	Ru
Liquifiable Layer		120	Vertical Stress Ratio			0.175	0	Water Surface	Custom	1	
Weathered Bedrock		120	Hoek-Brown					Water Surface	Custom	1	
Backfill		120	Mohr-Coulomb	0	36			Water Surface	Custom	1	
Alluvium (Qal)		120	Mohr-Coulomb	0	33			Water Surface	Custom	1	
Older Alluvium (Qoa)		120	Mohr-Coulomb	0	36			None			0



Leighton	*Project:* **Sandia Creek Drive Bridge Replacement**	
Analyzed By: EDB	*Units:* Feet	*Scale:* 1:360
Date: 11/26/2019	*Condition:* 12115.001	
Project No.: **Seismic Coefficient**	*File Name:* 12115 Sandia Creek Drive Bridge.slmd	

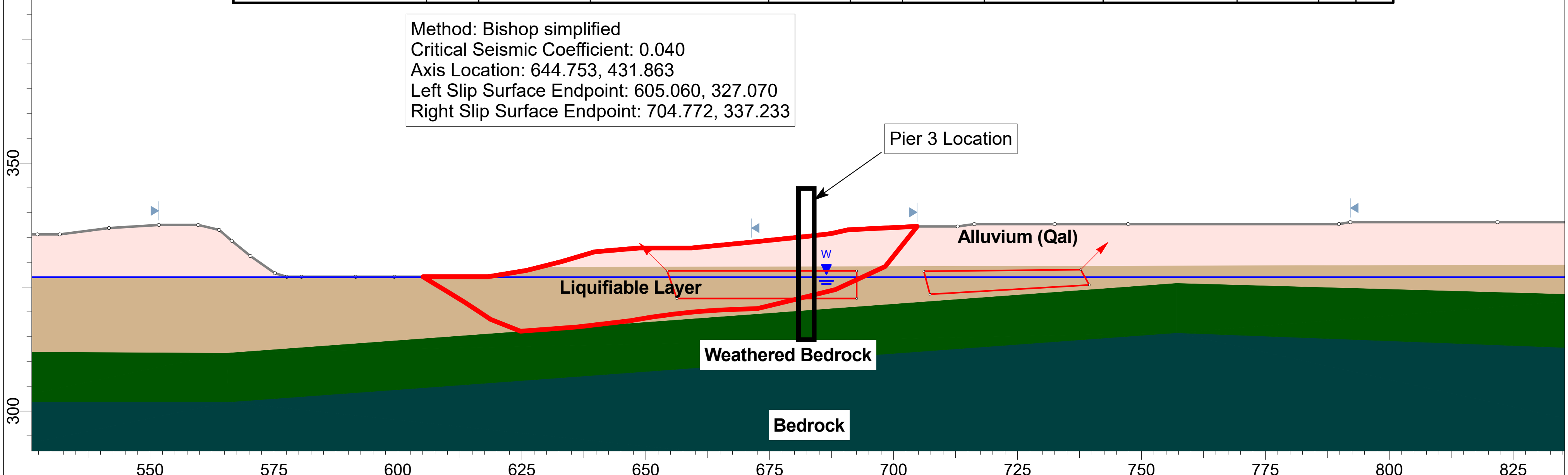
SLIDEINTERPRET 8.028

Sandia Creek Drive Bridge Replacement

Lateral Spread Potential

\\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Slide\New Proposed Bridge\12115 Sandia Creek Drive Bridge.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface	Hu Type	Hu	Ru
Liquifiable Layer		120	Vertical Stress Ratio			0.175	0	Water Surface	Custom	1	
Weathered Bedrock		120	Hoek-Brown					Water Surface	Custom	1	
Backfill		120	Mohr-Coulomb	0	36			Water Surface	Custom	1	
Alluvium (Qal)		120	Mohr-Coulomb	0	33			Water Surface	Custom	1	
Older Alluvium (Qoa)		120	Mohr-Coulomb	0	36			None			0



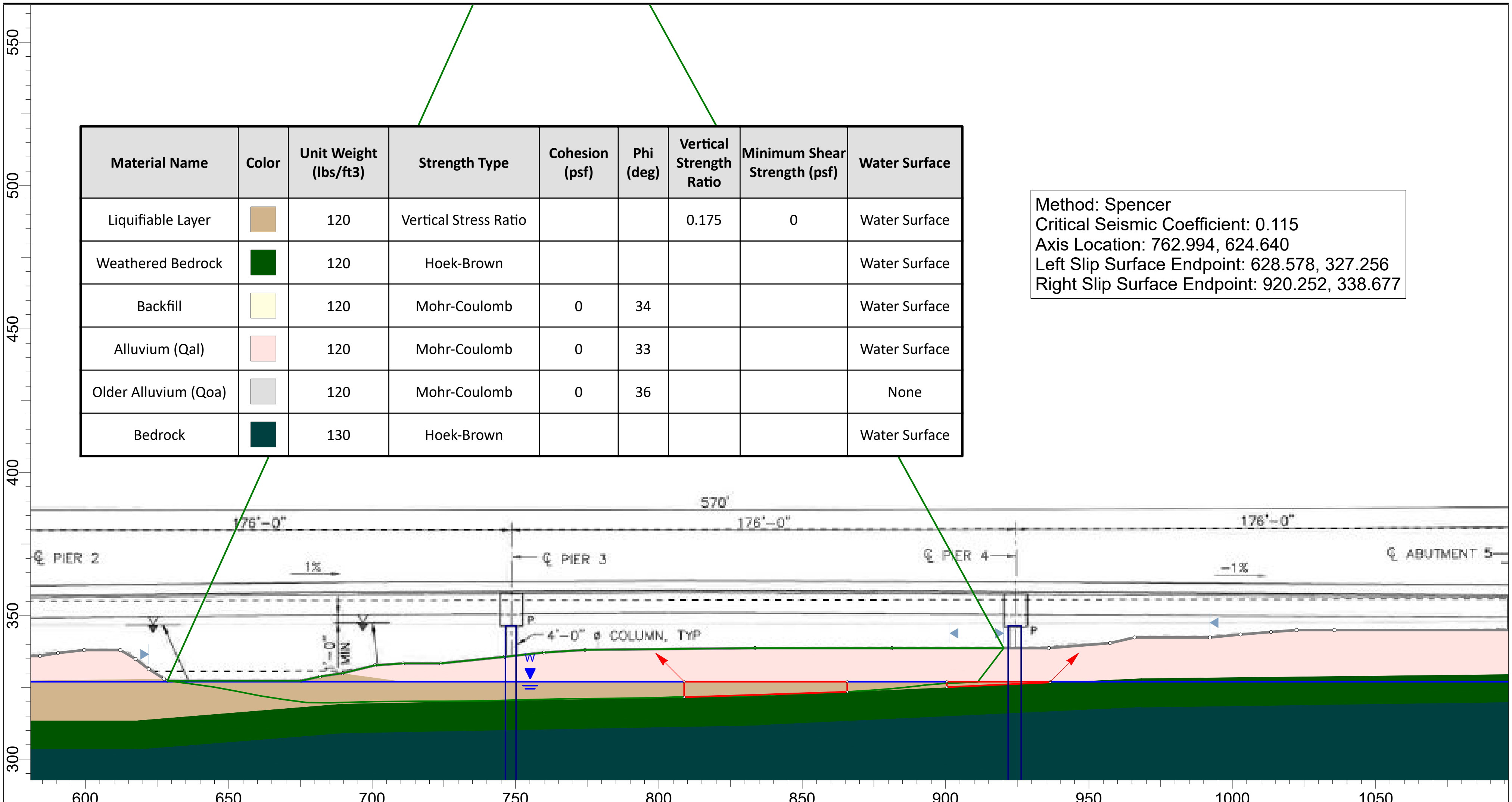
Project: **Sandia Creek Drive Bridge Replacement**				
Analyzed By: EDB	Units: Feet	Scale: 1:360	Project No.: **Seismic Coefficient**	File Name: 12115 Sandia Creek Drive Bridge.slmd
Date: 11/26/2019	Condition: 12115.001			

Leighton

SLIDEINTERPRET 8.028

Sandia Creek Drive Bridge Replacement

\\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Slide\New Proposed Bridge\12115 Sandia Creek Drive Bridge - Revised 2.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Vertical Strength Ratio	Minimum Shear Strength (psf)	Water Surface
Liquifiable Layer		120	Vertical Stress Ratio			0.175	0	Water Surface
Weathered Bedrock		120	Hoek-Brown					Water Surface
Backfill		120	Mohr-Coulomb	0	34			Water Surface
Alluvium (Qal)		120	Mohr-Coulomb	0	33			Water Surface
Older Alluvium (Qoa)		120	Mohr-Coulomb	0	36			None
Bedrock		130	Hoek-Brown					Water Surface

Method: Spencer
Critical Seismic Coefficient: 0.115
Axis Location: 762.994, 624.640
Left Slip Surface Endpoint: 628.578, 327.256
Right Slip Surface Endpoint: 920.252, 338.677

SLIDEINTERPRET 8.023

Leighton and Associates, Inc.
A LEIGHTON GROUP COMPANY

Project: Sandia Creek Drive Bridge Replacement				
Analyzed By: EDB	*Units:* feet	*Scale:* 1:600	*Project No.:* **12115.001**	*File Name:* 12115 Sandia Creek Drive Bridge - Revised 2.slmd
Date: 12/11/2019	*Condition:* **Seismic Coefficient**			

APPENDIX F

SHAFT ANALYSIS

Leighton

==

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

==

```
     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Extreme Event\
     Name of input data file     : Abutment 1 - Extreme Limit State.sf8d
     Name of output file         : Abutment 1 - Extreme Limit State.sf8o
     Name of plot output file    : Abutment 1 - Extreme Limit State.sf8p
     Name of runtime file        : Abutment 1 - Extreme Limit State.sf8r
```

Time and Date of Analysis

Date: December 13, 2019 Time: 08:34:29

Abutment 1 - Extreme

TOTAL LOAD = 750.0 TONS

NUMBER OF LAYERS = 4

WATER TABLE DEPTH = 0.0 FT.

SOIL INFORMATION

```
LAYER NO  1----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.250E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.115E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.000E+00

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.500E+01

  LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  2----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.500E+01

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.130E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.100E+01


LAYER NO  3----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.400E+02
   DEPTH, FT                                            = 0.130E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.600E+02
   DEPTH, FT                                            = 0.230E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.100E+01


LAYER NO  4----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                        = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT           = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.100E+07
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.600E+02
   DEPTH, FT                                            = 0.230E+02


   AT THE BOTTOM
```

```
  DIAMETER OF SOCKET, FT                                  = 0.400E+01
  SPACING OF DISCONTINUITIES,FT                           = 0.500E+01
  THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT              = 0.100E+00
  UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT          = 0.288E+07
  UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT      = 0.432E+06
  ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.          = 0.600E+07
  ROCK QUALITY DESIGNATION (RQD) %                        = 0.700E+02
  DEPTH, FT                                               = 0.100E+03


  LRFD RESISTANCE FACTOR (SIDE FRICTION)                 = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)                = 0.100E+01



(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    6.600  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.367E+07 LB/SQ IN




COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION
```

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    6.600  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.367E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
8.0	3.72	6.56	0.00	6.56	6.56	0.00	6.56
9.0	4.19	13.51	0.00	13.51	13.51	0.00	13.51
10.0	4.65	20.82	0.00	20.82	20.82	0.00	20.82
11.0	5.12	28.46	0.00	28.46	28.46	0.00	28.46
12.0	5.59	36.42	0.00	36.42	36.42	0.00	36.42
13.0	6.05	44.67	0.00	44.67	44.67	0.00	44.67
14.0	6.52	64.82	0.00	64.82	64.82	0.00	64.82
15.0	6.98	77.40	0.00	77.40	77.40	0.00	77.40
16.0	7.45	90.88	0.00	90.88	90.88	0.00	90.88
17.0	7.91	105.28	0.00	105.28	105.28	0.00	105.28
18.0	8.38	120.58	0.00	120.58	120.58	0.00	120.58
19.0	8.84	136.80	0.00	136.80	136.80	0.00	136.80
20.0	9.31	153.93	0.00	153.93	153.93	0.00	153.93
21.0	9.78	171.97	0.00	171.97	171.97	0.00	171.97
22.0	10.24	190.92	0.00	190.92	190.92	0.00	190.92
23.0	10.71	210.75	2714.34	2925.09	210.75	2714.34	2925.09

WARNING MESSAGE

Ec/Em =   9.65

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.4054E+02	0.1181E-01
0.6080E+02	0.1771E-01
0.9120E+02	0.2656E-01
0.1368E+03	0.3985E-01
0.2052E+03	0.5977E-01
0.3078E+03	0.8965E-01
0.4617E+03	0.1345E+00
0.6872E+03	0.2017E+00
0.1013E+04	0.3026E+00
0.1501E+04	0.4539E+00
0.2233E+04	0.6808E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00

```
==========================================================================

                  SHAFT for Windows, Version 2017.8.10

                   Serial Number :  158517381

                 VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                  (c) Copyright ENSOFT, Inc., 1987-2017
                        All Rights Reserved

==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Service\
     Name of input data file     : Abutment 1 - Limit.sf8d
     Name of output file         : Abutment 1 - Limit.sf8o
     Name of plot output file    : Abutment 1 - Limit.sf8p
     Name of runtime file        : Abutment 1 - Limit.sf8r


     --------------------------------------------------------------------------
                          Time and Date of Analysis
     --------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:18:04



     PROPOSED DEPTH =      23.0 FT
     ----------------


     NUMBER OF LAYERS =    4
     ------------------


     WATER TABLE DEPTH =       0.0 FT.
     -------------------



     SOIL INFORMATION
     ---------------
```

```
LAYER NO  1----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.250E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.115E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.000E+00

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.500E+01

  LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  2----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.500E+01

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.130E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  3----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.130E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.230E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  4----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.100E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.230E+02


   AT THE BOTTOM
```

```
  DIAMETER OF SOCKET, FT                                 = 0.400E+01
  SPACING OF DISCONTINUITIES,FT                          = 0.500E+01
  THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT             = 0.100E+00
  UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT         = 0.288E+07
  UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT     = 0.432E+06
  ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.         = 0.600E+07
  ROCK QUALITY DESIGNATION (RQD) %                       = 0.700E+02
  DEPTH, FT                                              = 0.100E+03


  LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.100E+01



(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    6.600  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.367E+07 LB/SQ IN




COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION
```

DIAMETER OF STEM	=	4.000	FT.
DIAMETER OF BASE	=	4.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	6.600	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	18.098	SQ.IN.
ELASTIC MODULUS, Ec	=	0.367E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.
SHAFT LENGTH	=	23.000	FT.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
7.0	3.26	10.41	0.00	10.41	10.41	0.00	10.41
8.0	3.72	6.56	0.00	6.56	6.56	0.00	6.56
9.0	4.19	13.51	0.00	13.51	13.51	0.00	13.51
10.0	4.65	20.82	0.00	20.82	20.82	0.00	20.82
11.0	5.12	28.46	0.00	28.46	28.46	0.00	28.46
12.0	5.59	36.42	0.00	36.42	36.42	0.00	36.42
13.0	6.05	44.67	0.00	44.67	44.67	0.00	44.67
14.0	6.52	64.82	0.00	64.82	64.82	0.00	64.82
15.0	6.98	77.40	0.00	77.40	77.40	0.00	77.40
16.0	7.45	90.88	0.00	90.88	90.88	0.00	90.88
17.0	7.91	105.28	0.00	105.28	105.28	0.00	105.28
18.0	8.38	120.58	0.00	120.58	120.58	0.00	120.58
19.0	8.84	136.80	0.00	136.80	136.80	0.00	136.80
20.0	9.31	153.93	0.00	153.93	153.93	0.00	153.93
21.0	9.78	171.97	0.00	171.97	171.97	0.00	171.97
22.0	10.24	190.92	0.00	190.92	190.92	0.00	190.92
23.0	10.71	210.75	2714.34	2925.09	210.75	2714.34	2925.09

WARNING MESSAGE

Ec/Em = 9.65

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.4054E+02	0.1181E-01
0.6080E+02	0.1771E-01
0.9120E+02	0.2656E-01
0.1368E+03	0.3985E-01
0.2052E+03	0.5977E-01
0.3078E+03	0.8965E-01
0.4617E+03	0.1345E+00
0.6872E+03	0.2017E+00
0.1013E+04	0.3026E+00
0.1501E+04	0.4539E+00
0.2233E+04	0.6808E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00
0.2925E+04	0.8953E+00

```
                    Abutment 1 - Strength Limit State.sf8o
      =========================================================================

                    SHAFT for Windows, Version 2017.8.10

                     Serial Number :  158517381

                  VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                   (c) Copyright ENSOFT, Inc., 1987-2017
                         All Rights Reserved

      =========================================================================


      Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Strength\
      Name of input data file     : Abutment 1 - Strength Limit State.sf8d
      Name of output file         : Abutment 1 - Strength Limit State.sf8o
      Name of plot output file    : Abutment 1 - Strength Limit State.sf8p
      Name of runtime file        : Abutment 1 - Strength Limit State.sf8r


      -------------------------------------------------------------------------
                         Time and Date of Analysis
      -------------------------------------------------------------------------

                Date:  December 13, 2019     Time:  10:04:21



      TOTAL LOAD =     800.0 TONS
      ------------


      NUMBER OF LAYERS =    4
      ------------------


      WATER TABLE DEPTH =      20.0 FT.
      -------------------



      SOIL INFORMATION
      ---------------
```

```
LAYER NO  1----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.600E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.250E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.115E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.000E+00

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.600E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.700E+01

  LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00


LAYER NO  2----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.600E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.120E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.700E+01

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M              = 0.600E+00
  INTERNAL FRICTION ANGLE, DEG.                     = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.500E+02
  SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
  DEPTH, FT                                         = 0.150E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.700E+00


LAYER NO  3----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SLUMP OF CONCRETE, IN                              = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.400E+02
   DEPTH, FT                                          = 0.150E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SLUMP OF CONCRETE, IN                              = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.250E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.700E+00


LAYER NO  4----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.576E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.250E+02


   AT THE BOTTOM
```

```
  DIAMETER OF SOCKET, FT                                 = 0.400E+01
  SPACING OF DISCONTINUITIES,FT                          = 0.500E+01
  THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT             = 0.100E+00
  UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT         = 0.288E+07
  UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT     = 0.576E+06
  ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.         = 0.600E+07
  ROCK QUALITY DESIGNATION (RQD) %                       = 0.700E+02
  DEPTH, FT                                              = 0.100E+03


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.700E+00



(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    6.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN




COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION
```

DIAMETER OF STEM	=	4.000	FT.
DIAMETER OF BASE	=	4.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	6.700	FT.
IGNORED BOTTOM PORTION	=	0.000	FT.
AREA OF ONE PERCENT STEEL	=	18.098	SQ.IN.
ELASTIC MODULUS, Ec	=	0.360E+07	LB/SQ IN
VOLUME OF UNDERREAM	=	0.000	CU.YDS.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
8.0	3.72	13.63	0.00	13.63	9.54	0.00	9.54
9.0	4.19	21.36	0.00	21.36	14.95	0.00	14.95
10.0	4.65	29.44	0.00	29.44	20.60	0.00	20.60
11.0	5.12	37.84	0.00	37.84	26.49	0.00	26.49
12.0	5.59	46.55	0.00	46.55	32.59	0.00	32.59
13.0	6.05	55.56	0.00	55.56	38.89	0.00	38.89
14.0	6.52	64.86	0.00	64.86	45.40	0.00	45.40
15.0	6.98	74.43	0.00	74.43	52.10	0.00	52.10
16.0	7.45	87.91	0.00	87.91	61.54	0.00	61.54
17.0	7.91	102.30	0.00	102.30	71.61	0.00	71.61
18.0	8.38	117.61	0.00	117.61	82.32	0.00	82.32
19.0	8.84	133.82	0.00	133.82	93.68	0.00	93.68
20.0	9.31	150.96	0.00	150.96	105.67	0.00	105.67
21.0	9.78	169.00	0.00	169.00	118.30	0.00	118.30
22.0	10.24	187.94	0.00	187.94	131.56	0.00	131.56
23.0	10.71	207.77	0.00	207.77	145.44	0.00	145.44
24.0	11.17	228.78	0.00	228.78	160.14	0.00	160.14
25.0	11.64	251.10	2714.34	2965.44	175.77	1900.04	2075.81

WARNING MESSAGE

Ec/Em = 9.82

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.4268E+02	0.1215E-01
0.6403E+02	0.1822E-01
0.9604E+02	0.2733E-01
0.1441E+03	0.4100E-01
0.2161E+03	0.6150E-01
0.3241E+03	0.9225E-01
0.4861E+03	0.1384E+00
0.7157E+03	0.2076E+00
0.1041E+04	0.3113E+00
0.1529E+04	0.4670E+00
0.2261E+04	0.7005E+00
0.2965E+04	0.9251E+00
0.2965E+04	0.9251E+00
0.2965E+04	0.9251E+00
0.2965E+04	0.9251E+00

Bent 2 - Extreme - Compression.sf8o

==

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

==

Path to file locations : \\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Shaft\Extreme Event\
Name of input data file : Bent 2 - Extreme - Compression.sf8d
Name of output file : Bent 2 - Extreme - Compression.sf8o
Name of plot output file : Bent 2 - Extreme - Compression.sf8p
Name of runtime file : Bent 2 - Extreme - Compression.sf8r

Time and Date of Analysis

Date: December 12, 2019 Time: 14:23:07

Bent 2 - Strength - Compression

TOTAL LOAD = 850.0 TONS

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 17.0 FT.

SOIL INFORMATION

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.220E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.220E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.320E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.320E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.376E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.376E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	10.24	0.00	10.24	10.24	0.00	10.24
22.0	10.24	20.63	0.00	20.63	20.63	0.00	20.63
23.0	10.71	55.20	0.00	55.20	55.20	0.00	55.20
24.0	11.17	80.63	0.00	80.63	80.63	0.00	80.63
25.0	11.64	107.63	0.00	107.63	107.63	0.00	107.63
26.0	12.10	136.18	0.00	136.18	136.18	0.00	136.18
27.0	12.57	166.32	0.00	166.32	166.32	0.00	166.32
28.0	13.03	198.09	0.00	198.09	198.09	0.00	198.09
29.0	13.50	231.53	0.00	231.53	231.53	0.00	231.53
30.0	13.96	266.69	0.00	266.69	266.69	0.00	266.69
31.0	14.43	303.26	0.00	303.26	303.26	0.00	303.26
32.0	14.90	341.25	2714.34	3055.59	341.25	2714.34	3055.59

WARNING MESSAGE

Ec/Em = 6.03

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3889E+02	0.1294E-01
0.5834E+02	0.1941E-01
0.8751E+02	0.2911E-01
0.1313E+03	0.4367E-01
0.1969E+03	0.6551E-01
0.2953E+03	0.9826E-01
0.4430E+03	0.1474E+00
0.6611E+03	0.2211E+00
0.9865E+03	0.3316E+00
0.1475E+04	0.4974E+00
0.2207E+04	0.7462E+00
0.3056E+04	0.1035E+01
0.3056E+04	0.1035E+01
0.3056E+04	0.1035E+01
0.3056E+04	0.1035E+01

```
==========================================================================

                SHAFT for Windows, Version 2017.8.10

                 Serial Number :  158517381

               VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                (c) Copyright ENSOFT, Inc., 1987-2017
                      All Rights Reserved

==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Service\
     Name of input data file     : Pier 2 - Limit.sf8d
     Name of output file         : Pier 2 - Limit.sf8o
     Name of plot output file    : Pier 2 - Limit.sf8p
     Name of runtime file        : Pier 2 - Limit.sf8r


     --------------------------------------------------------------------------
                          Time and Date of Analysis
     --------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:19:23

     Bent 2 - Strength - Compression


     PROPOSED DEPTH =      32.0 FT
     ----------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      17.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.220E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.220E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.320E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.320E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   32.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
20.0	9.31	26.55	0.00	26.55	26.55	0.00	26.55
21.0	9.78	10.24	0.00	10.24	10.24	0.00	10.24
22.0	10.24	20.63	0.00	20.63	20.63	0.00	20.63
23.0	10.71	53.11	0.00	53.11	53.11	0.00	53.11
24.0	11.17	76.34	0.00	76.34	76.34	0.00	76.34
25.0	11.64	101.01	0.00	101.01	101.01	0.00	101.01
26.0	12.10	127.11	0.00	127.11	127.11	0.00	127.11
27.0	12.57	154.68	0.00	154.68	154.68	0.00	154.68
28.0	13.03	183.76	0.00	183.76	183.76	0.00	183.76
29.0	13.50	214.38	0.00	214.38	214.38	0.00	214.38
30.0	13.96	246.59	0.00	246.59	246.59	0.00	246.59
31.0	14.43	280.11	0.00	280.11	280.11	0.00	280.11
32.0	14.90	314.95	2714.34	3029.30	314.95	2714.34	3029.30

WARNING MESSAGE

Ec/Em = 5.77

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3891E+02	0.1313E-01
0.5836E+02	0.1970E-01
0.8754E+02	0.2954E-01
0.1313E+03	0.4432E-01
0.1970E+03	0.6647E-01
0.2955E+03	0.9971E-01
0.4432E+03	0.1496E+00
0.6611E+03	0.2243E+00
0.9865E+03	0.3365E+00
0.1475E+04	0.5048E+00
0.2207E+04	0.7572E+00
0.3029E+04	0.1041E+01
0.3029E+04	0.1041E+01

0.3029E+04	0.1041E+01
0.3029E+04	0.1041E+01

```
================================================================================

                    SHAFT for Windows, Version 2017.8.10

                     Serial Number :  158517381

                  VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                   (c) Copyright ENSOFT, Inc., 1987-2017
                          All Rights Reserved

================================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Strength\
     Name of input data file     : Pier 2 - Strength.sf8d
     Name of output file         : Pier 2 - Strength.sf8o
     Name of plot output file    : Pier 2 - Strength.sf8p
     Name of runtime file        : Pier 2 - Strength.sf8r


--------------------------------------------------------------------------------
                      Time and Date of Analysis
--------------------------------------------------------------------------------

          Date:  December 13, 2019     Time:  10:05:55

     Bent 2 - Strength - Compression


     TOTAL LOAD =    1200.0 TONS
     ------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =       9.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.220E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.700E+00


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.220E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.320E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.320E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.700E+02
   DEPTH, FT                                           = 0.750E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

```
COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION

-------------------------

 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.


PREDICTED RESULTS
-----------------

QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	9.18	0.00	9.18	6.43	0.00	6.43
22.0	10.24	18.53	0.00	18.53	12.97	0.00	12.97
23.0	10.71	78.34	0.00	78.34	54.84	0.00	54.84
24.0	11.17	131.31	0.00	131.31	91.92	0.00	91.92
25.0	11.64	186.99	0.00	186.99	130.89	0.00	130.89
26.0	12.10	245.29	0.00	245.29	171.70	0.00	171.70
27.0	12.57	306.23	0.00	306.23	214.36	0.00	214.36
28.0	13.03	369.84	0.00	369.84	258.89	0.00	258.89
29.0	13.50	436.17	0.00	436.17	305.32	0.00	305.32
30.0	13.96	505.25	0.00	505.25	353.68	0.00	353.68
31.0	14.43	576.44	0.00	576.44	403.51	0.00	403.51
32.0	14.90	649.72	2714.34	3364.07	454.81	1900.04	2354.85

WARNING MESSAGE

Ec/Em = 5.77

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3882E+02	0.1313E-01
0.5824E+02	0.1970E-01
0.8735E+02	0.2954E-01
0.1310E+03	0.4432E-01
0.1965E+03	0.6647E-01
0.2948E+03	0.9971E-01
0.4422E+03	0.1496E+00
0.6600E+03	0.2243E+00
0.9854E+03	0.3365E+00
0.1474E+04	0.5048E+00
0.2206E+04	0.7572E+00
0.3304E+04	0.1136E+01
0.3364E+04	0.1156E+01
0.3364E+04	0.1156E+01
0.3364E+04	0.1156E+01

Bent 3 - Extreme - Compression.sf8o

===

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

===

Path to file locations : \\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Shaft\Extreme Event\
Name of input data file : Bent 3 - Extreme - Compression.sf8d
Name of output file : Bent 3 - Extreme - Compression.sf8o
Name of plot output file : Bent 3 - Extreme - Compression.sf8p
Name of runtime file : Bent 3 - Extreme - Compression.sf8r

Time and Date of Analysis

Date: December 13, 2019 Time: 09:59:48

TOTAL LOAD = 850.0 TONS

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 8.0 FT.

SOIL INFORMATION

```
LAYER NO  1----SAND

  AT THE TOP

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
  DEPTH, FT                                          = 0.000E+00

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
  PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
  INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
  DEPTH, FT                                          = 0.155E+02

  LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

  AT THE TOP

  DIAMETER OF SOCKET, FT                              = 0.400E+01
  SLUMP OF CONCRETE, IN                               = 0.600E+01
  ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
  UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
  ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
  ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
  DEPTH, FT                                           = 0.155E+02


  AT THE BOTTOM

  DIAMETER OF SOCKET, FT                              = 0.400E+01
  SLUMP OF CONCRETE, IN                               = 0.600E+01
  ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
  UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
  ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
  ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
  DEPTH, FT                                           = 0.255E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.255E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

Bent 3 - Extreme - Compression.sf8o

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	19.03	0.00	19.03	19.03	0.00	19.03
22.0	10.24	39.02	0.00	39.02	39.02	0.00	39.02
23.0	10.71	59.95	0.00	59.95	59.95	0.00	59.95
24.0	11.17	81.81	0.00	81.81	81.81	0.00	81.81
25.0	11.64	104.69	0.00	104.69	104.69	0.00	104.69
26.0	12.10	128.95	2714.34	2843.30	128.95	2714.34	2843.30

WARNING MESSAGE

Ec/Em = 7.51

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3833E+02	0.1231E-01
0.5750E+02	0.1847E-01
0.8625E+02	0.2770E-01
0.1294E+03	0.4155E-01
0.1941E+03	0.6233E-01
0.2911E+03	0.9349E-01
0.4366E+03	0.1402E+00
0.6550E+03	0.2104E+00
0.9825E+03	0.3155E+00
0.1474E+04	0.4733E+00
0.2211E+04	0.7100E+00
0.2843E+04	0.9132E+00
0.2843E+04	0.9132E+00
0.2843E+04	0.9132E+00
0.2843E+04	0.9132E+00

```
==========================================================================

                  SHAFT for Windows, Version 2017.8.10

                   Serial Number :  158517381

                VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                 (c) Copyright ENSOFT, Inc., 1987-2017
                       All Rights Reserved

==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Service\
     Name of input data file     : Pier 3 - Limit.sf8d
     Name of output file         : Pier 3 - Limit.sf8o
     Name of plot output file    : Pier 3 - Limit.sf8p
     Name of runtime file        : Pier 3 - Limit.sf8r


     --------------------------------------------------------------------------
                          Time and Date of Analysis
     --------------------------------------------------------------------------

     Date:  December 13, 2019               Time:  10:20:29

     Pier 3 - Limit


     PROPOSED DEPTH =      26.0 FT
     ----------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =       8.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.350E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.155E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.155E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.255E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.255E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   26.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
20.0	9.31	26.61	0.00	26.61	26.61	0.00	26.61
21.0	9.78	16.87	0.00	16.87	16.87	0.00	16.87
22.0	10.24	34.61	0.00	34.61	34.61	0.00	34.61
23.0	10.71	53.21	0.00	53.21	53.21	0.00	53.21
24.0	11.17	72.66	0.00	72.66	72.66	0.00	72.66
25.0	11.64	93.05	0.00	93.05	93.05	0.00	93.05
26.0	12.10	114.68	2714.34	2829.02	114.68	2714.34	2829.02

WARNING MESSAGE

Ec/Em = 7.51
Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3833E+02	0.1231E-01
0.5750E+02	0.1847E-01
0.8625E+02	0.2770E-01
0.1294E+03	0.4155E-01
0.1941E+03	0.6233E-01
0.2911E+03	0.9349E-01
0.4366E+03	0.1402E+00
0.6550E+03	0.2104E+00
0.9825E+03	0.3155E+00
0.1474E+04	0.4733E+00
0.2211E+04	0.7100E+00
0.2829E+04	0.9086E+00
0.2829E+04	0.9086E+00
0.2829E+04	0.9086E+00
0.2829E+04	0.9086E+00

==

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

==

Path to file locations : \\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Shaft\Strength\
Name of input data file : Pier 3 - Strength.sf8d
Name of output file : Pier 3 - Strength.sf8o
Name of plot output file : Pier 3 - Strength.sf8p
Name of runtime file : Pier 3 - Strength.sf8r

Time and Date of Analysis

Date: December 13, 2019 Time: 10:06:48

TOTAL LOAD = 1200.0 TONS

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 8.0 FT.

SOIL INFORMATION

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                        = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
   DEPTH, FT                                         = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                        = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
   DEPTH, FT                                         = 0.155E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.600E+01
   SLUMP OF CONCRETE, IN                              = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.400E+02
   DEPTH, FT                                          = 0.155E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.600E+01
   SLUMP OF CONCRETE, IN                              = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.255E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.255E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.700E+02
   DEPTH, FT                                           = 0.750E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

```
COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION

-------------------------

 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.


PREDICTED RESULTS
-----------------

QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	25.31	0.00	25.31	17.71	0.00	17.71
22.0	10.24	51.92	0.00	51.92	36.34	0.00	36.34
23.0	10.71	79.82	0.00	79.82	55.87	0.00	55.87
24.0	11.17	109.00	0.00	109.00	76.30	0.00	76.30
25.0	11.64	139.58	0.00	139.58	97.71	0.00	97.71
26.0	12.10	172.02	2714.34	2886.36	120.41	1900.04	2020.45

WARNING MESSAGE

Ec/Em = 7.51

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3833E+02	0.1231E-01
0.5750E+02	0.1847E-01
0.8625E+02	0.2770E-01
0.1294E+03	0.4155E-01
0.1941E+03	0.6233E-01
0.2911E+03	0.9349E-01
0.4366E+03	0.1402E+00
0.6550E+03	0.2104E+00
0.9825E+03	0.3155E+00
0.1474E+04	0.4733E+00
0.2211E+04	0.7100E+00
0.2886E+04	0.9270E+00
0.2886E+04	0.9270E+00
0.2886E+04	0.9270E+00
0.2886E+04	0.9270E+00

```
                    Bent 4 - Extreme - Compression.sf8o
     ==========================================================================

                   SHAFT for Windows, Version 2017.8.10

                    Serial Number :  158517381

                 VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                  (c) Copyright ENSOFT, Inc., 1987-2017
                        All Rights Reserved

     ==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Extreme Event\
     Name of input data file     : Bent 4 - Extreme - Compression.sf8d
     Name of output file         : Bent 4 - Extreme - Compression.sf8o
     Name of plot output file    : Bent 4 - Extreme - Compression.sf8p
     Name of runtime file        : Bent 4 - Extreme - Compression.sf8r


     --------------------------------------------------------------------------
                         Time and Date of Analysis
     --------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:01:21



     TOTAL LOAD =     850.0 TONS
     ------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      21.0 FT.
     -------------------



     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.600E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.115E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.600E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.500E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.130E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.130E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.230E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.230E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

```
COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION

-------------------------

 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.


PREDICTED RESULTS
-----------------

QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

Bent 4 - Extreme - Compression.sf8o

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	19.22	0.00	19.22	19.22	0.00	19.22
22.0	10.24	39.41	0.00	39.41	39.41	0.00	39.41
23.0	10.71	60.54	2714.34	2774.88	60.54	2714.34	2774.88

WARNING MESSAGE

Ec/Em = 6.92

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3809E+02	0.1187E-01
0.5714E+02	0.1780E-01
0.8571E+02	0.2670E-01
0.1286E+03	0.4005E-01
0.1928E+03	0.6008E-01
0.2893E+03	0.9012E-01
0.4339E+03	0.1352E+00
0.6508E+03	0.2028E+00
0.9762E+03	0.3042E+00
0.1464E+04	0.4562E+00
0.2197E+04	0.6843E+00
0.2775E+04	0.8645E+00
0.2775E+04	0.8645E+00
0.2775E+04	0.8645E+00
0.2775E+04	0.8645E+00

```
==========================================================================

                 SHAFT for Windows, Version 2017.8.10

                  Serial Number :  158517381

               VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                (c) Copyright ENSOFT, Inc., 1987-2017
                      All Rights Reserved

==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Service\
     Name of input data file     : Pier 4 - Limit.sf8d
     Name of output file         : Pier 4 - Limit.sf8o
     Name of plot output file    : Pier 4 - Limit.sf8p
     Name of runtime file        : Pier 4 - Limit.sf8r


     --------------------------------------------------------------------------
                     Time and Date of Analysis
     --------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:22:17

     Pier 4 - Limit


     PROPOSED DEPTH =      23.0 FT
     ----------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      21.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.600E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.115E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.600E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.500E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.130E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.130E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SLUMP OF CONCRETE, IN                               = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.230E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                        = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT           = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.600E+02
   DEPTH, FT                                            = 0.230E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                        = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT           = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.700E+02
   DEPTH, FT                                            = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   23.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
20.0	9.31	28.01	2714.34	2742.35	28.01	2714.34	2742.35
21.0	9.78	17.77	0.00	17.77	17.77	0.00	17.77
22.0	10.24	36.44	0.00	36.44	36.44	0.00	36.44
23.0	10.71	56.01	2714.34	2770.35	56.01	2714.34	2770.35

WARNING MESSAGE

Ec/Em = 6.92

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3809E+02	0.1187E-01
0.5714E+02	0.1780E-01
0.8571E+02	0.2670E-01
0.1286E+03	0.4005E-01
0.1928E+03	0.6008E-01
0.2893E+03	0.9012E-01
0.4339E+03	0.1352E+00
0.6508E+03	0.2028E+00
0.9762E+03	0.3042E+00
0.1464E+04	0.4562E+00
0.2197E+04	0.6843E+00
0.2770E+04	0.8631E+00
0.2770E+04	0.8631E+00
0.2770E+04	0.8631E+00
0.2770E+04	0.8631E+00

===

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

===

Path to file locations : \\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Shaft\Strength\
Name of input data file : Bent 4 - Strength - Compression.sf8d
Name of output file : Bent 4 - Strength - Compression.sf8o
Name of plot output file : Bent 4 - Strength - Compression.sf8p
Name of runtime file : Bent 4 - Strength - Compression.sf8r

Time and Date of Analysis

Date: December 11, 2019 Time: 09:59:40

TOTAL LOAD = 900.0 TONS

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 11.0 FT.

SOIL INFORMATION

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M               = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                      = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                         = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.100E+11
   DEPTH, FT                                          = 0.130E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.700E+00


 LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.600E+01
   SLUMP OF CONCRETE, IN                               = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.400E+02
   DEPTH, FT                                           = 0.130E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.600E+01
   SLUMP OF CONCRETE, IN                               = 0.400E+01
   ANGLE OF INTERFACE FRICTION, DEG.                   = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.230E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.700E+00


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.230E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                      = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT         = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.670E+07
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.700E+02
   DEPTH, FT                                          = 0.750E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.700E+00



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

```
COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION

-------------------------

 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   19.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.


PREDICTED RESULTS
-----------------

QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

Bent 4 - Strength - Compression.sf8o

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
21.0	9.78	66.53	0.00	66.53	46.57	0.00	46.57
22.0	10.24	136.85	0.00	136.85	95.80	0.00	95.80
23.0	10.71	211.04	2714.34	2925.39	147.73	1900.04	2047.77

WARNING MESSAGE

Ec/Em = 6.92

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3809E+02	0.1187E-01
0.5714E+02	0.1780E-01
0.8571E+02	0.2670E-01
0.1286E+03	0.4005E-01
0.1928E+03	0.6008E-01
0.2893E+03	0.9012E-01
0.4339E+03	0.1352E+00
0.6508E+03	0.2028E+00
0.9762E+03	0.3042E+00
0.1464E+04	0.4562E+00
0.2197E+04	0.6843E+00
0.2925E+04	0.9114E+00
0.2925E+04	0.9114E+00
0.2925E+04	0.9114E+00
0.2925E+04	0.9114E+00

Abutment 5 - Extreme.sf8o

```
=========================================================================

                SHAFT for Windows, Version 2017.8.10

                 Serial Number :  158517381

              VERTICALLY LOADED DRILLED SHAFT ANALYSIS
               (c) Copyright ENSOFT, Inc., 1987-2017
                     All Rights Reserved

=========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Extreme Event\
     Name of input data file     : Abutment 5 - Extreme.sf8d
     Name of output file         : Abutment 5 - Extreme.sf8o
     Name of plot output file    : Abutment 5 - Extreme.sf8p
     Name of runtime file        : Abutment 5 - Extreme.sf8r


     -------------------------------------------------------------------------
                         Time and Date of Analysis
     -------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:03:03



     TOTAL LOAD =     750.0 TONS
     ------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      21.0 FT.
     -------------------



     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                        = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
   DEPTH, FT                                         = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M              = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                     = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                        = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.100E+11
   DEPTH, FT                                         = 0.150E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SLUMP OF CONCRETE, IN                              = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.400E+02
   DEPTH, FT                                          = 0.150E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                             = 0.400E+01
   SLUMP OF CONCRETE, IN                              = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                  = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT     = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.     = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                   = 0.600E+02
   DEPTH, FT                                          = 0.250E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.250E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.600E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.700E+02
   DEPTH, FT                                           = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

```
COMPUTATION RESULTS
-------------------



- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1



DRILLED SHAFT INFORMATION

-------------------------

 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.


PREDICTED RESULTS
-----------------

QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
16.0	7.45	23.40	0.00	23.40	23.40	0.00	23.40
17.0	7.91	38.89	0.00	38.89	38.89	0.00	38.89
18.0	8.38	55.35	0.00	55.35	55.35	0.00	55.35
19.0	8.84	72.78	0.00	72.78	72.78	0.00	72.78
20.0	9.31	91.18	0.00	91.18	91.18	0.00	91.18
21.0	9.78	110.54	0.00	110.54	110.54	0.00	110.54
22.0	10.24	130.85	0.00	130.85	130.85	0.00	130.85
23.0	10.71	152.09	0.00	152.09	152.09	0.00	152.09
24.0	11.17	174.58	0.00	174.58	174.58	0.00	174.58
25.0	11.64	198.48	2714.34	2912.82	198.48	2714.34	2912.82

WARNING MESSAGE

Ec/Em = 9.82

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3871E+02	0.1215E-01
0.5807E+02	0.1822E-01
0.8710E+02	0.2733E-01
0.1307E+03	0.4100E-01
0.1960E+03	0.6150E-01
0.2940E+03	0.9225E-01
0.4410E+03	0.1384E+00
0.6597E+03	0.2076E+00
0.9851E+03	0.3113E+00
0.1473E+04	0.4670E+00
0.2205E+04	0.7005E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00

Abutment 5 - Service.sf8o

==

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

==

Path to file locations : \\Ds-tem\project\Leighton - Infocus\12000 - 12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof Services\Analyses\Shaft\Service\
Name of input data file : Abutment 5 - Service.sf8d
Name of output file : Abutment 5 - Service.sf8o
Name of plot output file : Abutment 5 - Service.sf8p
Name of runtime file : Abutment 5 - Service.sf8r

Time and Date of Analysis

Date: December 13, 2019 Time: 10:23:19

Abutment 5 - Limit

PROPOSED DEPTH = 25.0 FT

NUMBER OF LAYERS = 3

WATER TABLE DEPTH = 21.0 FT.

SOIL INFORMATION

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M                = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                       = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                          = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.100E+11
   DEPTH, FT                                           = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M                = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                       = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                          = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.100E+11
   DEPTH, FT                                           = 0.150E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.100E+01


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.400E+02
   DEPTH, FT                                            = 0.150E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.600E+02
   DEPTH, FT                                            = 0.250E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.250E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.600E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.700E+02
   DEPTH, FT                                           = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.100E+01
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.100E+01



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   25.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
15.0	6.98	7.97	0.00	7.97	7.97	0.00	7.97
16.0	7.45	22.37	0.00	22.37	22.37	0.00	22.37
17.0	7.91	36.76	0.00	36.76	36.76	0.00	36.76
18.0	8.38	52.06	0.00	52.06	52.06	0.00	52.06
19.0	8.84	68.28	0.00	68.28	68.28	0.00	68.28
20.0	9.31	85.41	0.00	85.41	85.41	0.00	85.41
21.0	9.78	103.45	0.00	103.45	103.45	0.00	103.45
22.0	10.24	122.40	0.00	122.40	122.40	0.00	122.40
23.0	10.71	142.23	0.00	142.23	142.23	0.00	142.23
24.0	11.17	163.23	0.00	163.23	163.23	0.00	163.23
25.0	11.64	185.56	2714.34	2899.90	185.56	2714.34	2899.90

WARNING MESSAGE

Ec/Em = 9.82

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3871E+02	0.1215E-01
0.5807E+02	0.1822E-01
0.8710E+02	0.2733E-01
0.1307E+03	0.4100E-01
0.1960E+03	0.6150E-01
0.2940E+03	0.9225E-01
0.4410E+03	0.1384E+00
0.6597E+03	0.2076E+00
0.9851E+03	0.3113E+00
0.1473E+04	0.4670E+00
0.2205E+04	0.7005E+00
0.2900E+04	0.9220E+00
0.2900E+04	0.9220E+00
0.2900E+04	0.9220E+00
0.2900E+04	0.9220E+00

```
==========================================================================

                  SHAFT for Windows, Version 2017.8.10

                   Serial Number :  158517381

                VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                 (c) Copyright ENSOFT, Inc., 1987-2017
                       All Rights Reserved

==========================================================================


     Path to file locations      : \\Ds-tem\project\Leighton - Infocus\12000 -
12999\12115 KPFF Santa Margarita River Fish Passage\001 Prof
Services\Analyses\Shaft\Strength\
     Name of input data file     : Abutment 5 - Strength.sf8d
     Name of output file         : Abutment 5 - Strength.sf8o
     Name of plot output file    : Abutment 5 - Strength.sf8p
     Name of runtime file        : Abutment 5 - Strength.sf8r


     --------------------------------------------------------------------------
                         Time and Date of Analysis
     --------------------------------------------------------------------------

               Date:  December 13, 2019     Time:  10:05:13



     TOTAL LOAD =     800.0 TONS
     ------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      21.0 FT.
     -------------------



     SOIL INFORMATION
     ---------------
```

```
 LAYER NO  1----SAND

   AT THE TOP

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M                = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                       = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.250E+02
   SOIL UNIT WEIGHT, LB/CU FT                          = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.100E+11
   DEPTH, FT                                           = 0.000E+00

   AT THE BOTTOM

   SIDE FRICTION PROCEDURE, KULHAWY AND CHEN METHOD
   PRECONSOLIDATION STRESS EXPONENT - M                = 0.700E+00
   INTERNAL FRICTION ANGLE, DEG.                       = 0.330E+02
   BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.300E+02
   SOIL UNIT WEIGHT, LB/CU FT                          = 0.120E+03
   MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.100E+11
   DEPTH, FT                                           = 0.150E+02

   LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.700E+00


LAYER NO  2----WEAK ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.240E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.185E+04
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.372E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.400E+02
   DEPTH, FT                                            = 0.150E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                               = 0.400E+01
   SLUMP OF CONCRETE, IN                                = 0.600E+01
   ANGLE OF INTERFACE FRICTION, DEG.                    = 0.300E+02
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT       = 0.100E+05
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.       = 0.800E+06
   ROCK QUALITY DESIGNATION (RQD) %                     = 0.600E+02
   DEPTH, FT                                            = 0.250E+02
```

```
   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.700E+00


LAYER NO  3----STRONG ROCK

   AT THE TOP

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.171E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.127E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.600E+02
   DEPTH, FT                                           = 0.250E+02


   AT THE BOTTOM

   DIAMETER OF SOCKET, FT                              = 0.400E+01
   SPACING OF DISCONTINUITIES,FT                       = 0.500E+01
   THICKNESS OF INDIVIDUAL DISCONTINUITIES,FT          = 0.100E+00
   UNIAXIAL COMPRESSION STRENGTH OF ROCK,LB/SQ FT      = 0.288E+07
   UNIAXIAL COMPRESSION STRENGTH OF CONCRETE,LB/SQ FT  = 0.432E+06
   ELASTIC MODULUS FOR THE INTACT ROCK, LB/SQ IN.      = 0.600E+07
   ROCK QUALITY DESIGNATION (RQD) %                    = 0.700E+02
   DEPTH, FT                                           = 0.500E+02


   LRFD RESISTANCE FACTOR (SIDE FRICTION)            = 0.700E+00
   LRFD RESISTANCE FACTOR (TIP RESISTANCE)           = 0.500E+00



 (*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



 INPUT DRILLED SHAFT INFORMATION
 ------------------------------

  MINIMUM SHAFT DIAMETER    =    4.000  FT.
  MAXIMUM SHAFT DIAMETER    =    4.000  FT.
  RATIO BASE/SHAFT DIAMETER =    0.000  FT.
  ANGLE OF BELL             =    0.000  DEG.
```

```
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =   14.700  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
16.0	7.45	23.40	0.00	23.40	16.38	0.00	16.38
17.0	7.91	38.89	0.00	38.89	27.22	0.00	27.22
18.0	8.38	55.35	0.00	55.35	38.74	0.00	38.74
19.0	8.84	72.78	0.00	72.78	50.95	0.00	50.95
20.0	9.31	91.18	0.00	91.18	63.82	0.00	63.82
21.0	9.78	110.54	0.00	110.54	77.38	0.00	77.38
22.0	10.24	130.85	0.00	130.85	91.59	0.00	91.59
23.0	10.71	152.09	0.00	152.09	106.47	0.00	106.47
24.0	11.17	174.58	0.00	174.58	122.21	0.00	122.21
25.0	11.64	198.48	2714.34	2912.82	138.93	1357.17	1496.10

WARNING MESSAGE

Ec/Em = 9.82

Ec/Em SHOULD BE GREATER THAN 10.0 AND LESS THAN 500.0

AXIAL LOAD VS SETTLEMENT CURVES

LOAD SETTLEMENT RELATIONSHIP

TOP LOAD TONS	TOP MOVEMENT IN.
0.3871E+02	0.1215E-01
0.5807E+02	0.1822E-01
0.8710E+02	0.2733E-01
0.1307E+03	0.4100E-01
0.1960E+03	0.6150E-01
0.2940E+03	0.9225E-01
0.4410E+03	0.1384E+00
0.6597E+03	0.2076E+00
0.9851E+03	0.3113E+00
0.1473E+04	0.4670E+00
0.2205E+04	0.7005E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00
0.2913E+04	0.9261E+00

FOR REDUCED PLANS
ORIGINAL SCALE IS IN INCHES

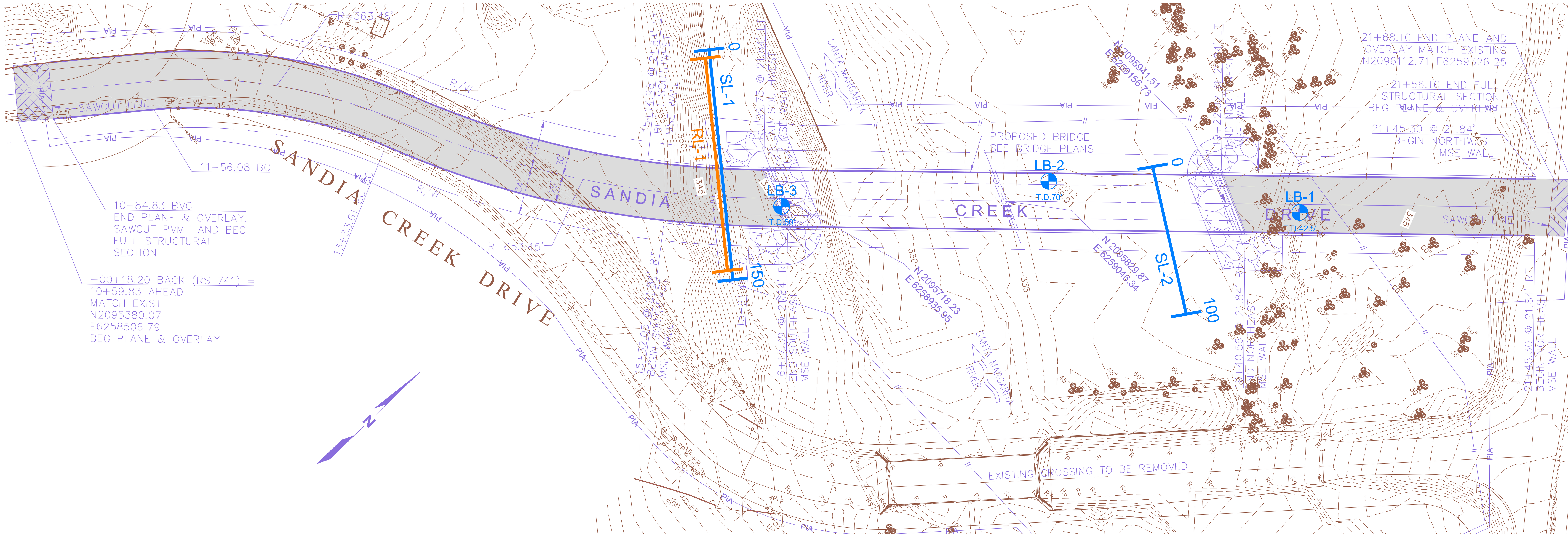
-1 0 1 2 3 4 5 6 7 8 9 10

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
CIVIL
STATE OF CALIFORNIA

PLANS	BY	DATE
DESIGNED	----	----
CHECKED	----	----

REGISTERED CIVIL ENGINEER DATE

65% SUBMITTAL - NOT FOR CONSTRUCTION

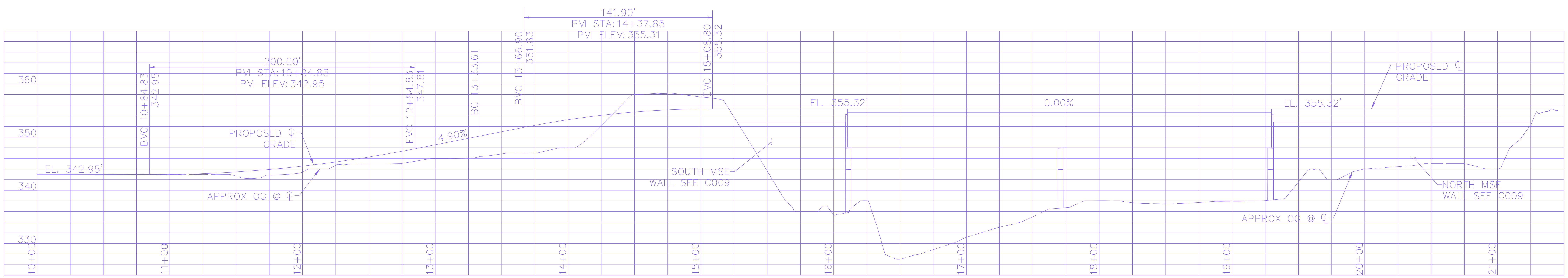


LEGEND:

ASPHALT CONCRETE PAVEMENT

PLANE & OVERLAY EXISTING PAVEMENT

PLAN
1"=40'



PROFILE
HOR: 1"=40'
VER: 1"=10'

Plate-1	EXPLORATION LOCATION MAP Sandia Creek Drive Bridge Replacement Project San Diego County, California	
Leighton	Proj: 12115.001	Eng/Geol: VPI/JMP
	Scale: 1"=40'	Date: April 2019

LEGEND

LB-3 T.D.50' — Boring location (Leighton, 2019)

SL-2 — Seismic line (SGI, 2018)

RL-1 — Remi line (SGI, 2018)

GRAPHIC SCALE
40 0 20 40 80 160
(IN FEET)
1 inch = 40ft.

Full Size = 22" x 34", Half Size = 11" x 17"

COUNTY OF SAN DIEGO
DEPARTMENT OF PUBLIC WORKS
5500 OVERLAND AVENUE, SAN DIEGO, CA 92123-1295

REVISIONS	BY	APPROVED	DATE

COORDINATE INDEX
XXXX N. XXXX E.
CONST. COMPL.
FIELD REVISIONS

Sandia Creek Road
Bridge Replacement
APPROACH ROADWAY PLAN & PROFILE

SCALE: HOR. 1"=40' VERT. 1"=10'
W.A. XXXX R.S. XXXX
CIVIL PLAN 8C OF 12C
SHEET 8 OF 36 SHEETS

V:\Drafting\12115\001\CAD\2018-08-20\12115-001_P01_ELM_2019-04-30.dwg Tuesday, Apr. 30 2019 4:55pm btran

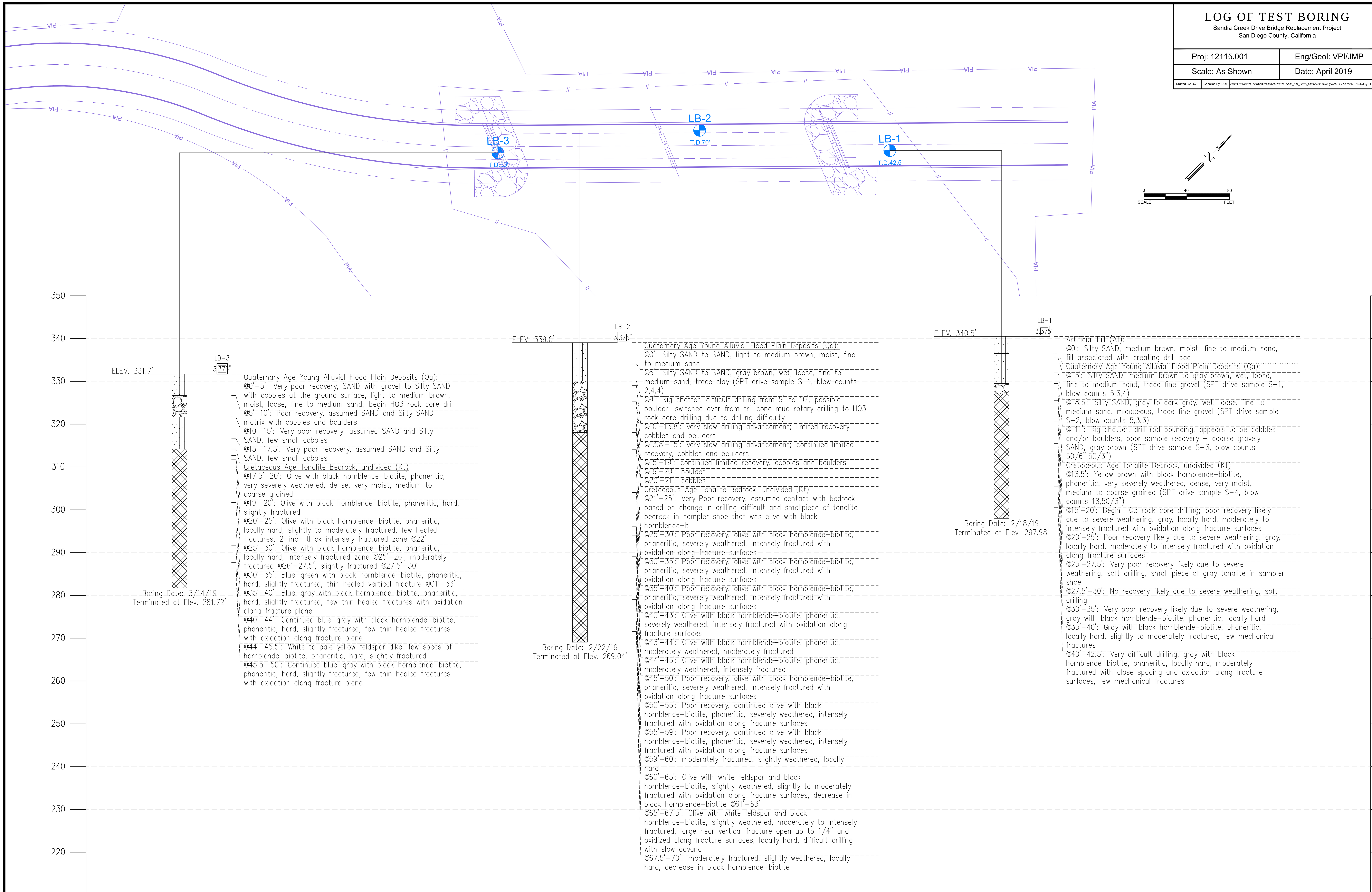
LOG OF TEST BORING

Sandia Creek Drive Bridge Replacement Project
San Diego County, California

Proj: 12115.001	Eng/Geol: VPI/JMP
Scale: As Shown	Date: April 2019

Plate 2

Leighton



Vertical Scale: 1"=10'