APPENDIX D: Preliminary Geologic and Seismic Hazards Report

DIAZ•YOURMAN
& ASSOCIATES
Geotechnical Services

A Report Prepared for:

Michael Baker International
5 Hutton Centre, Suite 500
Santa Ana, California 92707

PRELIMINARY GEOLOGIC AND SEISMIC HAZARDS REPORT
SANTA ANA RIVER TRAIL PHASE VI
ORANGE COUNTY, CALIFORNIA

Project No. 2018-020

by

Britton Howay

Britton Howay, EIT
Staff Engineer II

Somadevan Niranjanan
Geotechnical Engineer 2819

REGISTERED PROFESSIONAL ENGINEER
SOMADEVAN NIRANJANAN
No. GE2819
GEOTECHNICAL
★ STATE OF CALIFORNIA ★

Diaz•Yourman & Associates
1616 East 17th Street
Santa Ana, CA 92705-8509
(714) 245-2920

May 11, 2020

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1 INTRODUCTION

Diaz•Yourman & Associates (DYA) has prepared this preliminary Geologic and Seismic Hazards Report for the proposed Santa Ana River Trail (SART) Phase 6 (Project) for the Riverside County Transportation Commission (RCTC). In addition to RCTC, Riverside County Regional Parks and Open-Space Districts (Parks), Chino Hills State Park, San Bernardino County, and Orange County Public Works (OCPW) are part of the Project stakeholders. The Project proposes a new trail segment through the Green River Golf Course. The Project is currently in the Project Approval and Environmental Document (PA/ED) phase. DYA is a subconsultant to Michael Baker International. Michael Baker International authorized our services in May 18, 2018 with a written contract.

This report is intended to be used by the Project team to assist in the development of the Initial Study/Mitigated Negative Declaration (IS/MND) documents. The information provided in this report is based on available information from desktop study. No geotechnical field exploration and/or geotechnical laboratory testing has been performed for preparation of this report.

1.1 PROJECT DESCRIPTION

The proposed Project consists of a 1.5-mile multi use trail segment through the Green River Golf Course and a 0.2-mile segment between Phase 5 and Phase 3 of the larger 110-mile Regional SART. The Project consists of two build alternatives as discussed in Section 1.2. The Project Vicinity is shown in Figure 1. More specifically, the Project proposes construction of a paved Class 1 bikeway and a natural surface riding and hiking trail, connecting the future Santa Ana River Parkway Extension on the west in Orange County with the existing SART Phase 5 in Chino Hills State Park on the east within Riverside County. Additionally, the 0.2-mile segment involves a Class 1 multi-use path/natural surface trail connecting the eastern terminus of the SART – Phase 5 and the western terminus of SART Phase 3 near the SR-91 and SR- 71 interchange in Riverside County. The Project site encompasses a separate surface parking lot and staging area located to the south off Green River Road west of Green River Golf Course Drive.

A comprehensive schematic of the proposed alternative details can be found in Attachment A.

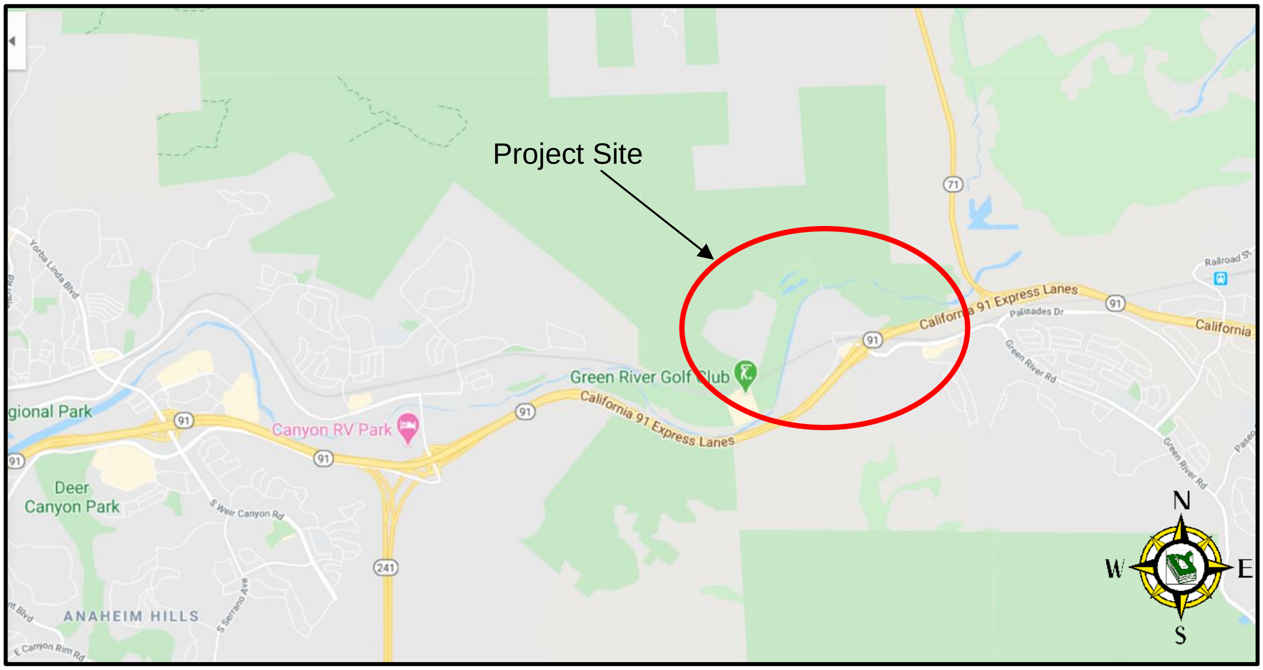


Figure 1 - VICINITY MAP

1.2 PROJECT ALTERNATIVES

The design team evaluated two alternatives for the proposed Project, see Appendix A. These alternatives include the following:

- Alternative 1: This Alternative will extend along the western boundary of the golf course.
- Alternative 2: This Alternative will extend along the eastern boundary of the golf course.

Both build alternatives would have similar trail characteristics and would close the gap between the Santa Ana River Parkway Extension and SART Phase 5 as well as between SART Phase 5 and SART Phase 3.

1.2.1 Alternative 1

The southwesterly end of the proposed project alignment would connect with the eastern terminus of the future Santa Ana River Parkway Extension at the Orange County/San Bernardino County line south of the existing Burlington Northern Santa Fe (BNSF) rail line.

Alternative 1 generally extends east-west (within the existing golf course) south of, and parallel to, the BNSF rail line until it reaches the golf course parking lot.

From the parking lot, Alternative 1 would extend north, spanning the BNSF railroad tracks via a proposed bridge. Once it crosses the BNSF railroad tracks, the trail would continue north along the existing maintenance road. A bridge or low water crossing is planned to cross Aliso Creek. The trail would then continue north/northeast and connect with the SART Phase 5 in Chino Hills State Park. See Appendix A for proposed Alternative 1 alignment.

1.2.2 Alternative 2

Similar to Alternative 1, Alternative 2 would connect with the eastern terminus of the future Santa Ana River Parkway Extension at the Orange County/San Bernardino County line south of the BNSF railroad tracks. Prior to the golf course parking lot, the Class I multi-use path/natural surface trail would extend north over the BNSF railroad tracks via a proposed bridge, similar to Alternative 1.

After crossing over the BNSF tracks, the trail would extend east parallel to the rail line before heading north along an existing dirt maintenance road parallel to the Santa Ana River. A low water crossing would be installed to cross Aliso Creek. Alternative 2 would continue in a northeast direction before turning to the northwest along the northern boundary of the golf course to intersect with an existing dirt maintenance road (Alternative 1) and connect with SART Phase 5 in Chino Hills State Park.

1.2.3 ADDITIONAL TRAIL ALIGNMENT

Both build alternatives would include construction of the approximate 1,000-foot long segment of the SART located east of the golf course. This portion of the SART would connect the eastern terminus of the existing SART Phase 5 with the western terminus of future SART Phase 3 near the State Route 91 and State Route 71 interchange.

2 SCOPE OF WORK

The purpose of our study was to address potential geologic and seismic hazards that could impact the Project. The scope of our services consisted of the following tasks:

- Reviewing available data.
- Preparing this Geologic and Seismic Hazards Report.

The future scope is expected to include preparing Preliminary Foundation Report (PFR) for type selection phase. Once the type selection phase is completed, we will perform site specific geotechnical exploration and laboratory testing to prepare a foundation report (FR) for proposed bridge(s). A material report will be prepared to address trail pavement sections and grading recommendations.

3 DATA REVIEW

Geological and geotechnical data from the Project vicinity presented in publications and previous reports were reviewed. A list of the documents reviewed is presented in the bibliography (Section 8). Our review included published documents available from the following:

- California Geologic Survey (CGS, 2020).
- United States Geologic Survey (USGS 2020).
- Federal Emergency Management Agency (FEMA 2008).
- General Plan and Safety Element for the County of Riverside (2019).
- General Plan for the City of Chino Hills (2015).
- General Plan 2040 for the City of Corona (2019).
- Geotechnical Appendix, Design Documentation Report for the Lower Santa Ana River prepared for the US Army Corps of Engineers by URS (2017).
- California Department of Water Resources website (2020).

Selected relevant data are included in Appendix B.

4 EXISTING CONDITIONS AND POTENTIAL HAZARDS

Site Geology, seismicity, and groundwater level are important factors to be considered when determining the design criteria and the possible impacts they may have on the Project. This section will discuss geology, faults, groundwater level, and liquefaction hazards as well as other subsurface conditions that affect the Project alignment.

4.1 GEOLOGY, SURFACE/SUBSURFACE CONDITIONS, AND GROUNDWATER LEVEL

4.1.1 Regional and Local Geologic Setting

The Project Alignment lies within Peninsular Ranges geomorphic province of Southern California. The province is bounded to the east by the Colorado Desert and extends south into lower California and west to include the Santa Catalina, Santa Barbara, and San Clemente Island groups. The province includes the Los Angeles Basin and is bounded to the north/northwest by the Transverse Ranges (CGS, 2002). The Project alignment is located within the Santa Ana River Floodplain along the Orange County and San Bernardino County boundaries and is bounded to the northwest by the Chino Hills and to the south by the Santa Ana Mountains. Over time, the Santa Ana River has incised the underlying bedrock creating varying levels of terraces. These bedrock terraces were then overlain by alluvial deposits. The geology in the area is mapped as containing Older Elevated Terrace (Qt) and (Qtl) deposits, which are described as dense to very dense silty sand, sand, and gravel as well as Quaternary Active Wash (Qal) described as loose silty sand and gravelly sand deposits and Quaternary Slope Wash deposits consisting of sand and silty sand. All deposits were also indicated to include cobbles.

4.1.2 Topography, Slopes, and Major Drainage

The topography map of the proposed Project alignments was provided by Michael Baker (2020) for our review. In general, the proposed Project alignments are on flat topography with minor elevations in surface grades. The Alternative 1 begins in the south at an approximate elevation of 430 feet and gradually increases to an approximate elevation of 450 feet at the north end. The proposed Alternative 2, begins in the south at an approximate elevation of 420 feet and gradually increases to an approximate elevation of 450 feet at the north end. These elevations are based on NADV 88 datum.

The Santa Ana River is the major drainage system adjacent to the proposed Project alignments. The proposed Project alignments would be north of the Santa Ana River.

4.1.3 Subsurface Soil Conditions

The subsurface information developed by URS (2017) from a site approximately 0.5 to 1 mile east of the Project site, was used to interpolate the subsurface conditions as there is no other existing subsurface information available to us. In general, the soil consisted of sandy silt or silty sand, well-graded or poorly graded sand with silt and gravel, well-graded or poorly graded gravel with silt and sand, and occasional layers of lean clay or fat clay to depths of about 20 to 30 feet bgs. Below those layers to a depth of 60 to 75 bgs, the soil consisted of silty sand, well-graded or poorly graded sand with silt and gravel, well-graded or poorly graded gravel with silt and sand, and occasional layers of lean clay or fat clay. Cobbles were encountered throughout the depths of exploration. See Appendix B for the subsurface data from the boring logs prepared by URS.

4.1.4 Groundwater

Based on review of CGS Prado Dam Quadrangle Historically Highest Ground Water (HHGW) Contours (2000), the groundwater in the vicinity of the Project has been reported as shallow as 10 feet bgs. No relevant groundwater data from the Water Data Library of the Department of Water Resources (2020) was available in the immediate vicinity of the Project. The most recent groundwater data comes from the borings performed in 2011 (URS, 2017) that are approximately 0.5 to 1 mile east of the Project site. Groundwater was encountered from a depth of 6 to 15 feet bgs. Based on the data above and the proximity of the Project location to the Santa Ana River running just south of the Project, groundwater may be encountered for excavations greater than five (5) feet bgs. See Appendix B for the groundwater information found in the boring logs prepared by URS and Appendix C for the CGS HHGW Contours.

Based on the information provided above, the potential to encounter groundwater in excavations as shallow as 6 feet bgs.

Relevant groundwater data is provided in Appendix C.

4.2 FAULTING AND SEISMIC HAZARDS

Southern California is in a region with many known faults and high seismic activity. Faults are fractures in the Earth's crust, and when they are subjected to displacement, earthquakes can occur. The displacement of the fault can occur in four different ways: strike slip, normal, reverse, and thrust.

- Strike-slip faults are vertical fractures where the blocks have mostly moved horizontally.
- Normal, reverse, and thrust faults are inclined fractures where the blocks have mostly shifted vertically. If the rock mass above an inclined fault moves down, the fault is termed normal, whereas if the rock above the fault moves up, the fault is termed reverse. A thrust fault is a reverse fault with a dip of 45 degrees or less.
- Blind (buried) thrust faults do not rupture all the way up to the surface, so there is no evidence of the fault on the surface.

Depending on the fault displacement and amount of stress that has accumulated, the magnitude of the earthquakes can have a wide range. For the purpose of this Project, Table 1 was generated to show all the types of active faults and their respective maximum magnitude earthquake within the vicinity of the Project alignment.

Table 1 - MAJOR FAULT CHARACTERIZATION IN THE PROJECT VICINITY

		SITE-TO-SOURCE DISTANCE (km)					BASIN EFFECTS	
FAULT	**FID**	**R_x**	**R_{rup}**	**TYPE**	**M_{MAX}**	**DIP AND DIRECTION**	**$Z_{1.0}$ (m)**	**$Z_{2.5}$ (km)**
Elsinore (Glen Ivy) rev	365	0.70	0.872	SS	7.7	90°//V	N/A	N/A
Elsinore fault zone (Whittier Section)	352	0.936	0.904	SS	6.9	75°/NE		
Elsinore fault zone (Chino section)	355	3.774	2.891	SS	6.6	50°/SW		

Notes:

- Fault characterization is based on Caltrans ARS V2.3.09 database (2012).
- Project location: latitude = 33.878192° and longitude = -117.671304°
- FID = Fault Identification Number
- R_x is defined as the closest distance to the fault trace or surface projection of the top of the rupture plane.
- R_{rup} is defined as the closest distance from the Project site to the fault rupture plane. The distance measurements are approximate.
- M_{max} = Maximum magnitude earthquake
- SS = Strike Slip
- V = Vertical
- NE = Northeast
- SW = Southwest
- $Z_{1.0}$ = Depth to shear wave velocity of 1,000 m/s.
- $Z_{2.5}$ = Depth to shear wave velocity of 2,500 m/s.

4.2.1 Surface Faulting/Ground Rupture Hazard

Surface fault rupture refers to the extension of a fault from depth to the ground surface along which the ground breaks, resulting in displacement, such as vertical or horizontal offset. Surface fault ruptures are the result of stress relief during an earthquake event and often cause damage to structures within the rupture zone.

California's Alquist-Priolo Earthquake Fault Zoning Act (AP Act; CGS 2018) was enacted to identify and reduce the hazard from surface fault rupture by regulating project developments near active faults. The purpose of the AP Act is to prohibit the location of most structures intended for human occupancy across the trace of an active fault. The AP Act requires that projects in defined "Earthquake Fault Zones" conduct geologic investigations that demonstrate that the sites are not threatened by surface displacement from future fault rupture. To be zoned under the AP Act, a fault must be considered Holocene-active as defined (CGS 2018). CGS defines a Holocene-active fault as one that has had surface displacement within Holocene time (approximately the last 11,700 years). CGS considers a fault to be well defined if its trace is clearly detectable as a physical feature at or just below the ground surface.

CGS defines the following types of faults:

- **Age-undetermined Faults:** A fault whose age of most recent movement is not known or is unconstrained by dating methods or by limitations in stratigraphic resolution.
- **Holocene-active Faults:** A fault that has had surface displacement within Holocene time (last 11,700 years).
- **Pre-Holocene Faults:** A fault whose recency of past movement is older than 11,700 years, and thus does not meet criteria of Holocene-active fault.

According to the CGS Earthquake Zones of Required Investigation for the Prado Dam Quadrangle (2003), no part of the Project falls within an AP zone; see Attachment D. In addition, no part of the Project is within 1,000 feet of any Holocene or young age fault (Caltrans, 2013). Therefore, the potential for surface faulting with the Project alignments is low.

4.2.2 Seismic Ground Motion

Ground shaking intensity is influenced by several factors, such as distance to the epicenter and hypocenter from the site, the magnitude of the earthquake, and subsurface geologic structures, as well as surface topography, depth of groundwater, and strength of the earth materials underlying the site. The peak ground acceleration (PGA) was estimated based on the results of the Caltrans Acceleration Response Spectrum (ARS) V3.0.1 online tool (Caltrans, 2020). According to Caltrans Seismic Design Criteria V2.0 (2019) and the latest version of Caltrans ARS online tool, the ARS is developed based on probabilistic seismic hazard analysis (see Table 2). The shear wave velocity for the upper 30 meters (100 feet) of soils (V_{S30}) was considered to be 1,148 feet/second (approximately 350 meters per second [m/s]) based on published data (USGS, 2020).

Based on the results obtained from Caltrans ARS V3.0.1 online, the PGA for the Project site was 0.73g, with an associated mean magnitude (M) of 6.7.

Table 2 - DESIGN CALTRANS SPECTRAL ACCELERATION

Period (Second)	**Spectral Acceleration $S_{a2014\ (g)}$**
PGA	0.73
0.10	1.31
0.20	1.72
0.30	1.81
0.50	1.57
0.75	1.31
1.0	1.11
2.0	0.50
3.0	0.30
4.0	0.21
5.0	0.15

Note(s):

- PGA = Peak Ground Acceleration.
- Based on Caltrans ARS Online Tool V3.0.1 (2020).
- Based on 2014 version of USGS seismic hazard.

There is no direct geotechnical solution that we are aware of to mitigate the high seismic ground motion at a site. However, mitigation of high seismic ground motion consequences has been discussed in Section 4.2.3 in detail.

In general, this high seismic ground motion will have impact on the design of the proposed improvements such as bridge supports and retaining walls. Bridges shall be designed with isolation bearings which are placed between the super structure and supports to dampen ground shaking, providing large support width to minimize unseating potential of bridge structure, and providing highly ductile structure to withstand very large seismic displacement. Special analyses and design can also be implemented such as performing non-linear time history analyses for the ground motion evaluation. Accordance with Caltrans design guidelines, when a site PGA exceeds 0.6g, like this site, Caltrans standard walls cannot be used. A special design is required. Based on our experience, we understand that designers take the Caltrans standard plan walls and modify based on the seismic demands.

4.2.3 Liquefaction Potential and Seismic Settlement

Liquefaction occurs when saturated, low-relative-density, low-plastic materials are transformed from a solid to a near-liquid state. This phenomenon occurs when moderate to severe ground shaking causes pore-water pressure to increase. Site susceptibility to liquefaction is a function of the depth, density, soil type, and water content of granular sediments, along with the magnitude and frequency of earthquakes in the surrounding region. Saturated sands, silty sands, and unconsolidated silts within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects.

The Project site has not yet been mapped in the liquefaction zone mapping program by CGS as part of the Seismic Hazards Mapping Act. Review of geologic hazards maps (General Plan – Safety Element) available in the County of Riverside, revealed that a portion of the Project falls within an area mapped as moderately susceptible to liquefaction (2019); see Appendix E. Therefore, the potential for encountering liquefiable soils within the Project area is likely.

The liquefaction mitigation can be implemented by either performing appropriate ground improvements (mitigating the subsurface soils) or accommodating a structural solution to the foundation, typically a deep pile foundation tipping below the liquefiable layer.

To mitigate the effects from earthquake-induced liquefaction, several ground improvement techniques are available to consider. Deep dynamic compaction, vibro stone columns, deep cement-soil mixing, and jet grouting are some of the most common types of ground improvement techniques. Liquefaction mitigation measures, such as densification of subsurface soils or deep remedial grading, will likely not be cost effective. In addition to this, we recommend that the design team evaluate both options of either performing ground improvements for liquefaction mitigation or performing repairs after a seismic event.

The structural solution includes considering the liquefaction-induced downdrag loads because of the settling soils. The downdrag load calculation includes downward movement of any non-liquefiable layer (crust) and liquefiable layer. In order to accommodate these downdrag loads, the deep pile foundation will be selected so that the piles will be tipped below the bottom of the liquefiable layer.

The selection of the final option should also consider Project requirements, proposed improvements, availability of material locally, adjacent structures, proximity to residential/commercial facilities, and owner's and Project stakeholders' preferences and budget constraints. We believe during final design this issue can be analyzed in detail.

Because liquefaction potential exists at the Project site, lateral spreading due to liquefaction is a possibility at the Project site due to the sloping nature of the Project alignments from south to north.

Any proposed structures such as bridges, retaining walls, and habitable buildings that fall within the liquefaction zone will need to be designed based on an in-depth analysis of liquefaction and lateral spreading potential based on further investigations.

4.3 LANDSLIDE AND SLOPE INSTABILITY

The Project site has not yet been mapped by CGS for seismic hazards including landslides. A review of the County of Riverside Earthquake-Induced Slope Instability Map (2019), City of Chino Hills Landslide Susceptibility (2011), and the City of Corona Landslide Hazards Map (2011) determined that the Project is in an area that has a low susceptibility to landslides caused by earthquakes; see Appendix F. Therefore, the potential for the Project to be impacted by landslides is low.

4.4 SEICHES AND TSUNAMI

Seiches are large waves generated in enclosed bodies of water induced by ground shaking. The County of Riverside and the Cities of Corona and Chino Hills General Plans were reviewed to understand the potential effects from seiches for the Project site. Information about the potential for seiches was not provided in these plans. However, the Project site is located approximately two miles downstream form Prado Dam. According, to the County of Riverside Dam Hazard Map, the Project site is located in the Prado Dam Hazard Zone; see Attachment G.

Tsunamis are large waves generated in the sea by significant disturbance of the ocean flow, causing the water column above it to displace rapidly. Tsunamis are predominately caused by shallow underwater earthquakes and landslides. Because the Project location is not near any coastline, CGS has not mapped the Project quadrangle for any tsunami inundation; therefore, the there is no potential risks from a tsunami for the Project site.

4.5 FLOODING AND INUNDATION

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) for the Counties of San Bernardino (2008), Riverside (2008), and Orange (2009), the Project alignment is in areas mapped as Zone X and in other areas towards the south that have no printed FIRM data. Zone X refers to "areas determined to be outside the 0.2% annual chance floodplain." However, according to the City of Corona Flood Hazards Map (2016), the Project alignment is within a 100-year flood zone. Based on the proximity of the Santa Ana River and the Prado Dam to the Project alignment, the potential of flooding during extreme rain event (s) or dam failure could result in flooding of the Project area. See Appendix H for the FEMA FIRM maps and the City of Corona Flood Hazards Map. Therefore, the potential for the Project to be impacted by flooding is likely if the necessary events were to happen such as the failure of the Prado Dam or a 100-year storm event.

4.6 EXPANSIVE POTENTIAL

Expansive soils will undergo changes in volume with changes in moisture content (expand when saturated and shrink when dried), which can result in lifting and cracking of flatwork or paved surfaces. The County of Riverside and the City of Corona General Plans expansive soil potential maps were not available to review. However, according to the City of Chino Expansive Soils Map (2011), a portion of the Project alignment is in an area determined to have near surface soils with a moderate shrink-swell potential; see Appendix I. Therefore, the potential for encountering expansive soils within the Project site is low.

If expansive soils are encountered during geotechnical field exploration, removing these expansive soils and replacing with non-expansive soils is considered a possible remediation solution. Soil improvements such as lime or cement treating of the subsurface soils can also be considered another feasible option. Depending on the extent of the expansive soil and availability of the import materials such as fill soils, cement, and lime, and Project schedule and cost will mainly dictate the selection of appropriate method to be implemented.

As another remedial option to minimize the expansive potential during subsurface preparation is to compact soils beneath the pavement structural section with moisture content at least 2% higher than optimum.

4.7 TOPSOIL EROSION

The erodibility of the topsoil can happen when water and wind come in contact with a loosely compacted topsoil. The City of Chino Hills and Corona general plans documents did not have any information regarding the erodibility of the soil due to wind. According to the County of Riverside Wind Erosion Susceptibility Areas figure in the General Plan (2019), the Project site is in an area that is rated as low wind erodibility; see Appendix J. Therefore, the potential for the Project to be impacted by wind erosion is low.

4.8 CORROSION POTENTIAL

Soil corrosivity involves the measure of the potential for corrosion to steel and concrete in contact with the soil. Knowledge of potential soil corrosivity is often critical for the effective design parameters associated with cathodic protection of buried steel and concrete mix design for plain or reinforced-concrete buried project elements. Factors including soil composition, soil and pore water chemistry, moisture content, and pH affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, high sulfates, and high dissolved salts content are most corrosive. Generally, sands and silty sands do not present a corrosive environment. Clay soils, including those that contain interstitial saltwater, can be highly corrosive.

No corrosion test results were performed, but previous soil investigation and corrosion potential test results (0.5 to 1 mile east of Project site) were obtained from URS (2017). Based on review, the soils were interpreted to be non-corrosive based on Caltrans Corrosion guidelines (2018); see Appendix K for URS corrosion tests results. A summary of the corrosion test results is presented in Table 3.

Table 3 - EXISTING CORROSION TEST RESULTS

SAMPLE LOCATION	DEPTH (ft.)	pH	SULFATE (ppm)	CHLORIDE (ppm)	RESISTIVITY (ohm-cm)
Pier Group 2	6	6.6	11	ND	13,200
Pier Group 3	0 – 10	7.2	55	21	4,800
Pier Group 4	7	7.1	89	53	2,840
Pier Group 5	8	6.8	82	64	2,000

Note(s):

- Based on existing data from URS (2017).
- Based on Caltrans Corrosion Guidelines (Caltrans 2018): pH greater than 5.5, resistivity greater than 1,100 ohm-cm, Sulfate less than 1,500 ppm and Chloride less than 500 ppm.
- N.D. indicates not detected.
- ppm = parts per million.

We recommend that soil samples be collected where the new pavements and structures will be constructed and be tested during the design phase to evaluate corrosion potential in accordance with Caltrans corrosion criteria. In general, Caltrans requires that the soils or water have a minimum electrical resistivity of 1,100 ohm-cm; anything less indicates the presence of high soluble salts and a higher propensity for corrosion. For structural elements, the on-site soils should have a chloride concentration of 500 parts per million (ppm) or less, a sulfate concentration of 1,500 ppm or less, and a pH of 5.5 or greater per Caltrans corrosion guidelines (Caltrans, 2018). For any proposed fills, corrosion tests should be performed prior to importation.

5 LIMITATIONS

This Geologic and Seismic Hazard Report has been prepared for this Project in accordance with accepted geotechnical engineering practices common to the local area. No other warranty, expressed or implied, is made.

The information contained in this report is based on literature review only. The results of the previous field exploration indicate subsurface conditions only at the specific locations and times, and only to the depths penetrated. The information presented in this report should be confirmed or modified based on appropriate site-specific investigation during the preliminary/final design phases.

The data, opinions, and information contained in this report are applicable to the specific design element(s) and location(s) that is (are) the subject of this report. They have no applicability to any other design elements or to any other locations, and any and all subsequent users accept any and all liability resulting from any use or reuse of the data, opinions, and recommendations without the prior written consent of DYA.

Services performed by DYA have been conducted in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality under similar conditions. No other representation, expressed or implied, and no warranty or guarantee is included or intended.

This report is intended for use only for the Project described. In the event that any changes in the nature, design, or location of the facilities are planned, the information contained in this report should not be considered valid unless the changes are reviewed and information presented in this report is modified or verified in writing by DYA. We are not responsible for any claims, damages, or liability associated with the interpretation of subsurface data or reuse of the subsurface data or engineering analyses without our express written authorization.

6 BIBLIOGRAPHY

American Society of Civil Engineers, ASCE 7 Hazard Tool, https://asce7hazardtool.online, Accessed April 19, 2019.

California Department of Water Resources, 2020, Water Data Library, http://wdl.water.ca.gov/waterdatalibrary/, accessed in March 2020.

California Geological Survey, 2000, Seismic Hazard Zone Report for the Prado Dam 7.5 Minute Quadrangle, Orange County, California.

California Geological Survey, 2002, California Geomorphic Provinces, Note 36.

California Geological Survey, 2003, Zones of Required Investigation, Prado Dam 7.5 Minute Quadrangle, Revised May 1, 2003.

California Geological Survey 2018, Earthquake Fault Zones, A Guide for Government Agencies, Property Owners/Developers, And Geosciences Practitioners for Assessing Fault Rupture Hazards Revised 2018.

California Geological Survey, 2020, https://maps.conservation.ca.gov/cgs/informationwarehouse/regulatorymaps/, accessed March 2020.

Caltrans, 2012, Caltrans Fault Database (V2.3.09) for ARS online, October 23, 2012

Caltrans, 2013, Memo to Designer, 20-10 Fault Rupture, January 2013.

Caltrans, 2018, California Department of Transportation Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Branch, Corrosion Guidelines Version 3.0, March 2018.

Caltrans, 2019, Seismic Design Criteria V2.0, April 2019.

Caltrans, 2020, ARS Online Tool, Version 3.0.1, https://arsonline.dot.ca.gov/, accessed in March 2020.

City of Chino Hills, 2011, Landslide Susceptibility Figure 5-5, General Plan, Ch.5 Safety Element, March 14, 2011.

City of Chino Hills, 2011, Expansive Soils Figure 5-6, General Plan, Ch.5 Safety Element, March 14, 2011.

City of Chino Hills, 2015, General Plan, adopted February 24, 2015.

City of Corona, 2011, Landslide Hazard Figure PS-3, General Plan, 2011.

City of Corona, 2016, Flood Hazards Figure PS-5, General Plan, Public Review Draft 2019.

City of Corona, 2019, General Plan, Public Review Draft 2019.

County of Riverside General Plan, 2019, Safety Element, revised August 6, 2019.

Department of Water of Resources, 2020, Water Data Library.

Federal Emergency Management Agency (FEMA), Flood Insurance Rate Map, Riverside County (2008), Map Number 06065C0868G, Effective Date August 28, 2008.

Federal Emergency Management Agency, Flood Insurance Rate Map, San Bernardino County (2008), Map Number 06071C9345H, Map Revised August 28, 2008.

Federal Emergency Management Agency, Flood Insurance Rate Map, Orange County (2009), Map Number 06065C0868G, Map Revised December 3, 2009.

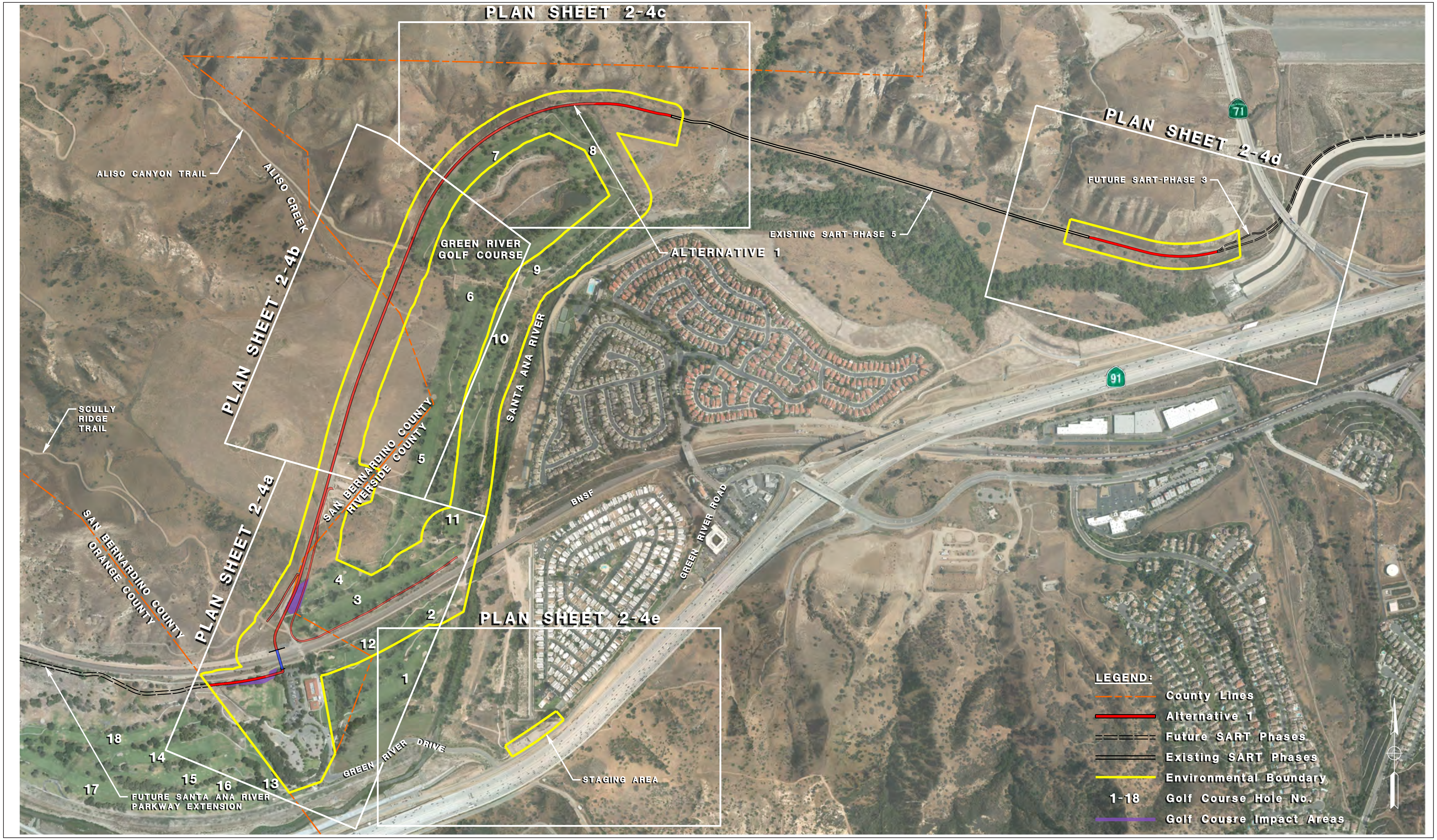
Michael Baker, Topographic Maps, 2020.

United States Geological Survey, 2020, Earthquake Hazards Program – USGS V_{s30} Data Information, Slope based V_{s30} Map Viewer. https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=8ac19bc334f747e486550f32837578e1. Vs_{30} Map Viewer, Accessed March 2020.

URS, 2017, Existing Geotechnical Appendix, Design Documentation Report for the Lower Santa Ana River, US Army Corps of Engineers, June 9, 2017.

Yerkes, et al., 1965, Geology of the Los Angeles Basin California-an Introduction, Geology of the Eastern Los Angeles Basin of Southern California, Geological Survey Professional Paper 420-A.

APPENDIX A -
PROJECT EXHIBITS



NOT TO SCALE

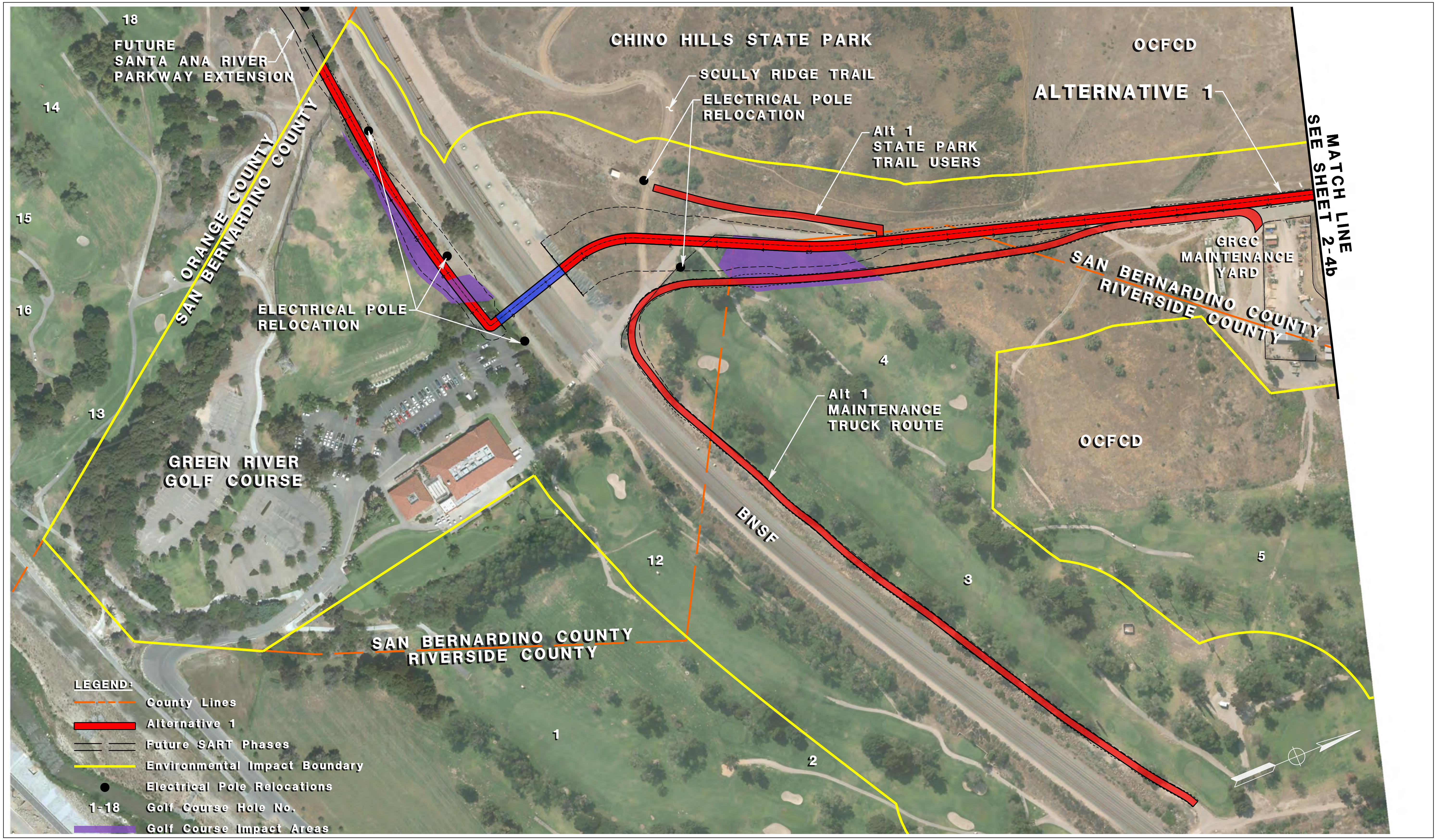
Michael Baker INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Conceptual Site Plan Key Map

Exhibit 2-4



NOT TO SCALE

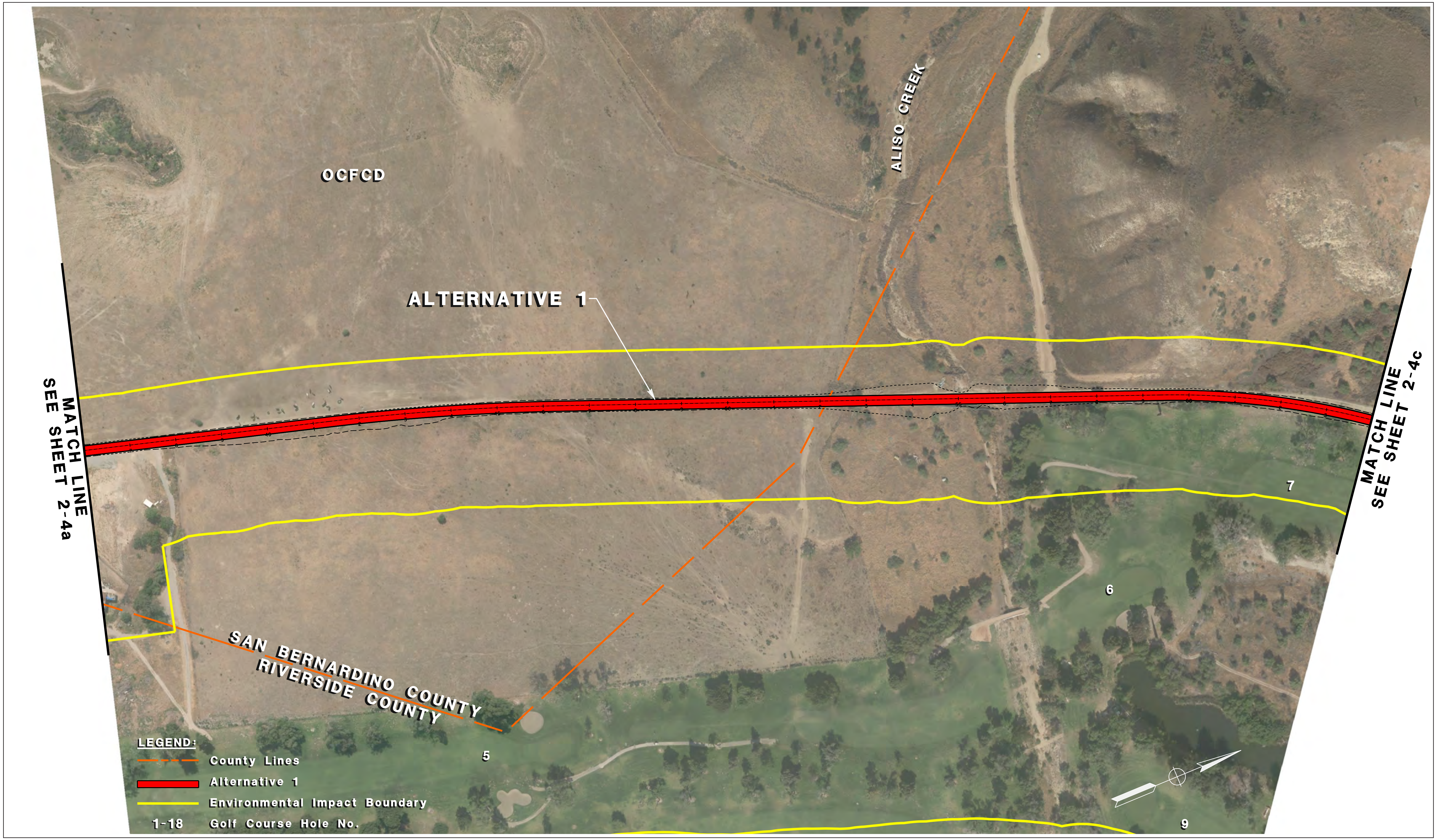
Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Plan Sheet 1

Exhibit 2-4a



NOT TO SCALE

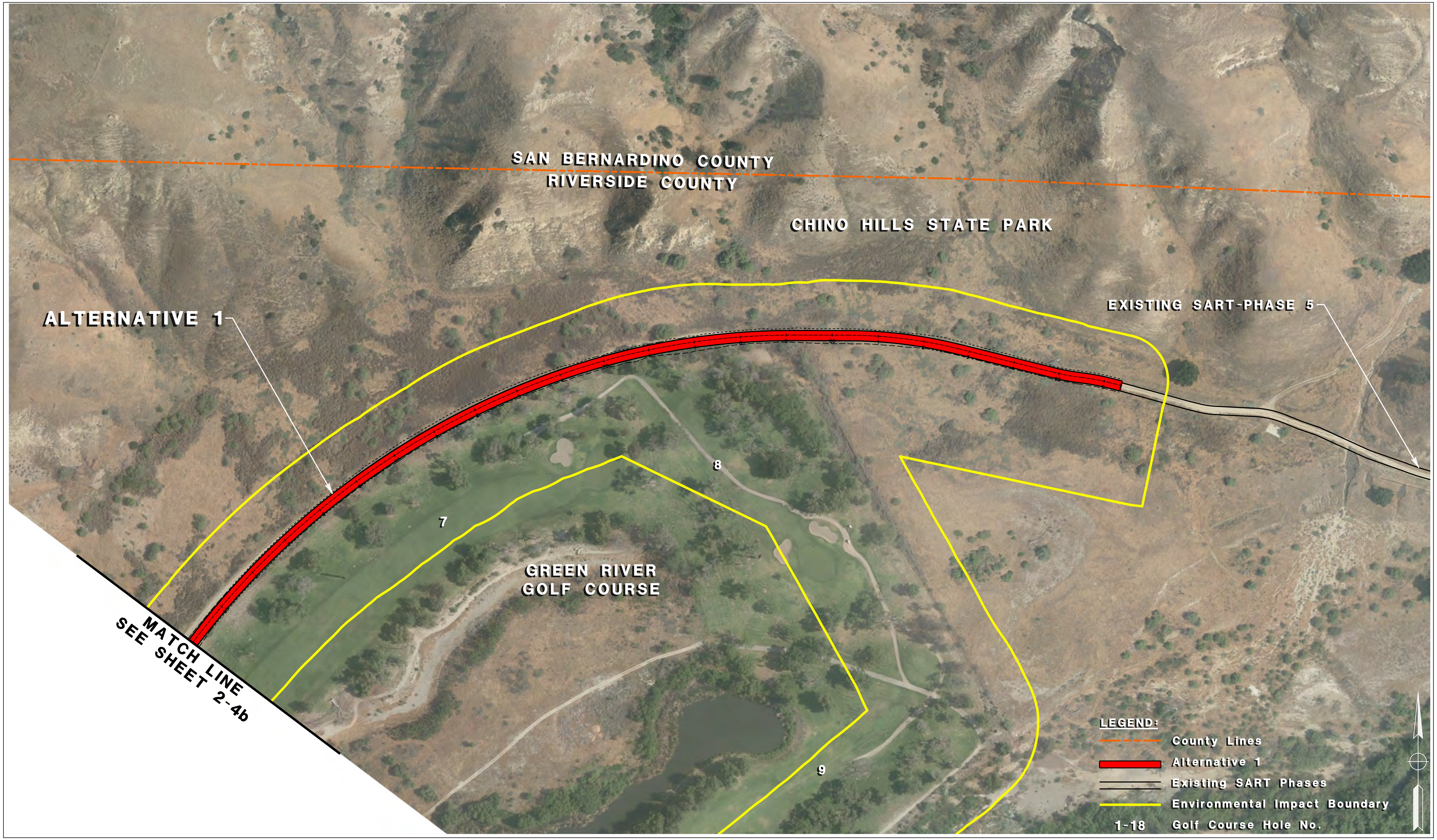
Michael Baker INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Plan Sheet 2

Exhibit 2-4b



NOT TO SCALE

Michael Baker INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Plan Sheet 3

Exhibit 2-4c

NOT TO SCALE

Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Plan Sheet 4

Exhibit 2-4d

NOT TO SCALE

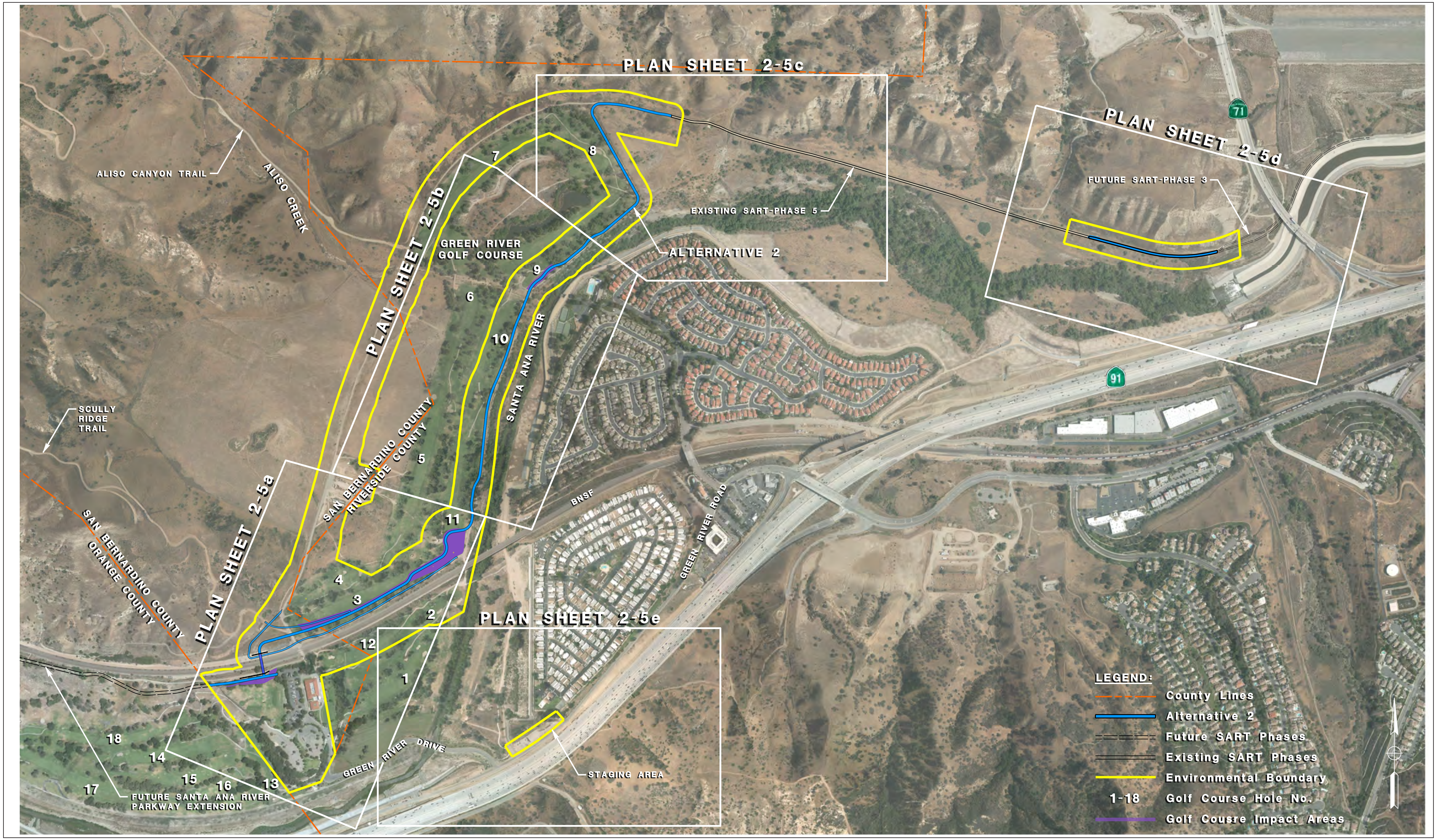
Michael Baker INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 1 Plan Sheet 5

Exhibit 2-4e



NOT TO SCALE

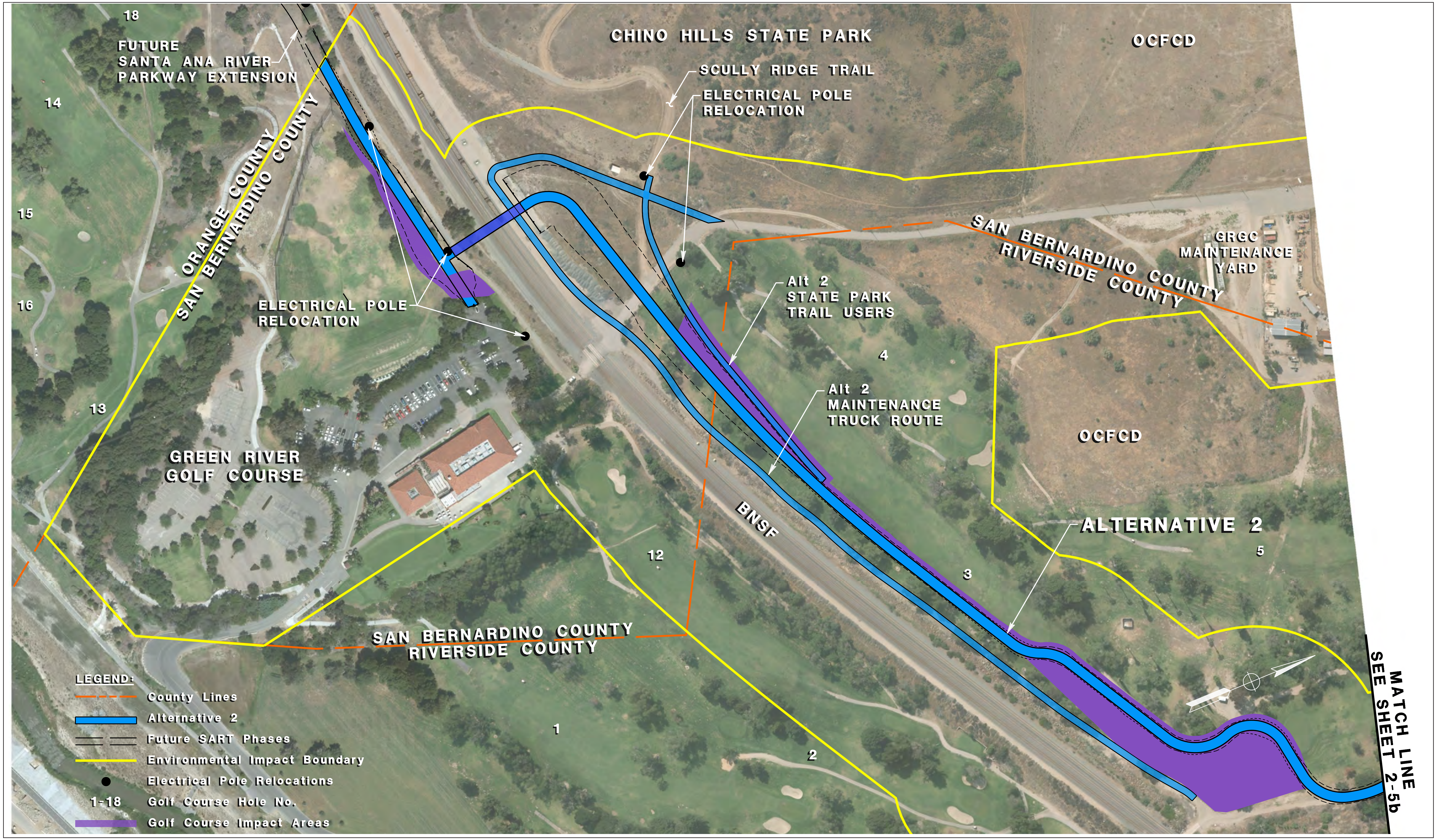
Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Conceptual Site Plan Key Map

Exhibit 2-5



NOT TO SCALE

Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Plan Sheet 1

Exhibit 2-5a

NOT TO SCALE

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Plan Sheet 2

Exhibit 2-5b

NOT TO SCALE

Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Plan Sheet 3

Exhibit 2-5c

NOT TO SCALE

Michael Baker
INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Plan Sheet 4

Exhibit 2-5d

NOT TO SCALE

Michael Baker INTERNATIONAL

01/2020 JN 167982

SANTA ANA RIVER TRAIL - PHASE 6 THROUGH GREEN RIVER GOLF COURSE
INITIAL STUDY/MITIGATED NEGATIVE DECLARATION

Alternative 2 Plan Sheet 5

Exhibit 2-5e

APPENDIX B -
EXISTING DATA

MICHAEL G. SMITH
No. 2229
Exp. 3-31-18

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Key to Log of Boring

Sheet 1 of 2

		ROCK CORE									SOIL SAMPLES				
Elevation, feet	Depth, feet	Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number		Lithology	MATERIAL DESCRIPTION	Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND LAB TESTS
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

COLUMN DESCRIPTIONS

1 **Elevation:** Elevation (in feet) referenced to mean sea level (MSL).

2 **Depth:** Distance (in feet) below the collar of the borehole.

3 **Run No.:** Number of the individual coring interval.

4 **Box No.:** Number of the core box which contains core from the corresponding run.

5 **Recovery:** Amount in percent of core recovered from coring interval; calculated as length of core recovered divided by length of run.

6 **Fractures per Foot:** (Fracture Frequency) The number of naturally occurring fractures in each foot of core; does not include mechanical breaks (induced by drilling) or healed fractures. "NA" indicates not applicable due to lack of core recovery.

7 **R Q D:** (Rock Quality Designation) Amount (in percent) of intact core (pieces of sound core greater than 4 inches in length) in each coring interval; calculated as the sum of lengths of intact core divided by length of core run. RQD of moderately weathered rock does not meet soundness requirements, but provides an indication of rock quality with respect to the degree of fracturing.

8 **Fracture Drawing:** Sketch of the naturally occurring fractures and mechanical breaks, showing the angle of the fractures relative to the cross-sectional axis of the core. "NR" indicates no recovery.

9 **Fracture Number:** Location of each naturally occurring fracture (numbered) and mechanical break (labeled "M"). Naturally occurring fractures are described in Column 11 (keyed by number) using descriptive terms defined on Sheet 2 (Items a through g).

10 **Lithology:** A graphic log of material encountered using symbols to represent soil and rock types; graphic symbols are explained below.

11 **Description:** Lithologic description in this order: rock type, color, grain size, texture, weathering, strength, and other features; descriptive terms are defined on Sheet 2. Also, abbreviated description of fractures numbered in Column 9 using terms defined on Sheet 2.

12 **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

13 **Sample Number:** Sample identification number.

14 **Blows / 6 in.:** Number of blows to advance driven sampler each 6-inch drive interval, or distance noted, using a 140-lb hammer with a 30-inch drop (unless otherwise noted).

15 **Drill Time [Rate]:** Time (in 24-hour clock) marking start and finish of each run; drill rate (in feet per hour) is reported in brackets.

16 **Field Notes and Lab Tests:** Comments and observations regarding drilling or sampling made by driller or field personnel. Lab tests are indicated using abbreviations explained below.

TYPICAL MATERIAL GRAPHIC SYMBOLS

░ POORLY GRADED SAND (SP)	░ POORLY GRADED SAND WITH SILT (SP-SM)	▥ SILTY SAND (SM)	▨ CLAYEY SAND (SC)
● POORLY GRADED GRAVEL (GP)	▥ SILT (ML)	▨ LEAN CLAY (CL)	▨ SILTY CLAY (CL-ML)
░ SANDSTONE	░ CLAYEY SANDSTONE	▤ SILTSTONE	● CONGLOMERATE

TYPICAL SAMPLER GRAPHIC SYMBOLS

▧ SPT split spoon	▩ Bulk or bucket sample
■ Modified California (2-inch ID), brass liners	☒ Grab or bag sample
◪ California (2.5-inch ID), brass liners	▤ Sonic core

Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

LABORATORY TEST ABBREVIATIONS

DD:	Dry density of soil, pounds per cubic foot (pcf)
M:	Moisture content of soil, % of dry weight of soil
LL:	Liquid Limit (from Atterberg Limits)
PI:	Plasticity Index (from Atterberg Limits), NP=nonplastic
PP:	Pocket penetrometer measurement, tsf
PA:	Particle analysis, % passing #200 (fines)

OTHER GRAPHIC SYMBOLS

▽ First water encountered at time of drilling

▼ Static water level measured after drilling completed

Report: GEO_CORE+SOIL_17LA_KEY; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 cpsoil/corekey

URS

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Key to Log of Boring

Sheet 2 of 2

KEY TO DESCRIPTIVE TERMS USED ON CORE LOGS

DISCONTINUITY DESCRIPTORS

a Dip of discontinuity, measured relative to a plane normal to the core axis.

b **Discontinuity Type:**

F - Fault
J - Joint
Sh - Shear
Fo - Foliation
V - Vein
B - Bedding

c **Aperture (inches):**

W - Wide (0.5-2.0)
MW - Moderately Wide (0.1-0.5)
N - Narrow (0.05-0.1)
VN - Very Narrow (<0.05)
T - Tight (0)

d **Type of Infilling:**

Bi - Biotite
Cl - Clay
Ca - Calcite
Ch - Chlorite
Ep - Epidote
Fe - Iron Oxide
H - Healed
K^+ - Potassium
Mn - Manganese
My - Mylonite
No - None
Py - Pyrite
Qz - Quartz
Sd - Sand
Si - Silty
Uk - Unknown

e **Amount of Infilling:**

Su - Surface Stain
Sp - Spotty
Pa - Partially Filled
Fi - Filled
No - None

f **Surface Shape of Joint:**

Pl - Planar
Wa - Wavy
St - Stepped
Ir - Irregular

g **Roughness of Surface:**

Slk - Slickensided [surface has smooth, glassy finish with visual evidence of striations]
S - Smooth [surface appears smooth and feels so to the touch]
SR - Slightly Rough [asperities on discontinuity surfaces are distinguishable and can be felt]
R - Rough [ridges and side-angle steps are evident; asperities are clearly visible; surface feels very abrasive]
VR - Very Rough [near-vertical steps and ridges occur on discontinuity surface]

ROCK FRACTURING

Description	Recognition
Intensely Fractured	Fractures spaced less than 2 inches apart
Highly Fractured	Fractures spaced 2 inches to 1 foot apart
Moderately Fractured	Fractures spaced 1 foot to 3 feet apart
Slightly Fractured	Fractures spaced 3 feet to 10 feet apart
Massive	Fracture spacing greater than 10 feet

ROCK WEATHERING / ALTERATION

Description	Recognition
Residual Soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broken by hand
Completely Weathered/Altered	Original minerals of rock have been almost entirely decomposed to secondary minerals, although original fabric may be intact; material can be granulated by hand
Highly Weathered/Altered	More than half of the rock is decomposed; rock is weakened so that a minimum 2-inch-diameter sample can be broken readily by hand across rock fabric
Moderately Weathered/Altered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2-inch-diameter sample cannot be broken readily by hand across rock fabric
Slightly Weathered/Altered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
Fresh/Unweathered	Rock shows no discoloration, loss of strength, or other effect of weathering/alteration

ROCK STRENGTH

Description	Recognition	Approximate Uniaxial Compressive Strength (psi)
Extremely Weak Rock	Can be indented by thumbnail	35 - 150
Very Weak Rock	Can be peeled by pocket knife	150 - 700
Weak Rock	Can be peeled with difficulty by pocket knife	700 - 3,600
Medium Strong Rock	Can be indented 5 mm with sharp end of pick	3,600 - 7,200
Strong Rock	Requires one hammer blow to fracture	7,200 - 14,500
Very Strong Rock	Requires many hammer blows to fracture	14,500 - 36,000
Extremely Strong Rock	Can only be chipped with hammer blows	>36,000

Report: GEO_CORE+SOIL_17LA_KEY; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 cpsoil/corekey

URS

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER MAINSTEM
LOWER SANTA ANA RIVER CHANNEL, REACH 9
BNSF RAILROAD BRIDGE PROTECTION
RIVERSIDE COUNTY, CALIFORNIA

KEY TO LOGS OF BORING

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: MGS
DRAWN BY: URS/EH
CHECKED BY: MGS/PRB

URS
999 TOWN & COUNTRY RD
ORANGE, CA 92868

SUBMITTED BY:
JAMES A. FARLEY, PE
CHIEF, GEOTECHNICAL BRANCH

DISTRICT FILE NO. 239/3843
SPEC. NO. W912PL-17-R-0046
FILE NAME: BNSF_PS02.DGN

Scale: AS SHOWN
SHEET
G-2

VIEW: SHEET SPACE VIEW

MICHAEL G. SMITH
No. 2229
Exp. 3-31-18

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 1 of 6

Date(s) Drilled	**5/29/12 - 5/31/12**	Logged By	**D. Orris and N. Jalali**	Checked By	**M. Hatch**
Drilling Method	**Rotary Wash to 66.5 ft; HQ-3 Wireline Core 66.5-92 ft**	Drill Bit Size/Type	**HWT casing with 4.7-in. "Nightmare" bit; 3.9-in. diamond-impregnated bit**	Total Depth of Borehole	**92.0 feet**
Drill Rig Type	**Fraste Multidrill XL (track-mounted)**	Drilling Contractor	**Gregg Drilling & Testing**	Approx. Ground Surface Elevation	**427.2 feet**
Groundwater Level	**Not measured**	Location	**Northing (feet): 625136.53 Easting (feet): 1569832.72**	Inclination from Horizontal/Bearing	**90° (vertical)**
Borehole Backfill	**Type II portland cement and bentonite grout mix (tremied)**	Sampling Method(s)	**Bulk, California, SPT, core**	Hammer Data	**Auto-trip hammer, 140 lbs with 30" drop [90.0%]**

Elevation, feet: 426, 424, 422, 420, 418, 416
Depth, feet: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	0								SANDY SILT (ML), light olive brown, dry to slightly moist, some fine- to medium-grained sand, few gravel, trace asphalt and construction debris **[FILL]**		B00			Start on 5/29/12. Hand auger to 5 ft. Collect bulk bucket sample from cuttings. Install ODEX conductor casing to 5 ft. PP=0.5-1.5 tsf
422	5								SANDY SILT (ML), medium stiff to stiff, olive brown, moist, some fine-grained and few medium- to coarse-grained sand **[ALLUVIUM]**		S1	10	1624	Recover 10 inches. PA: 58%<#200
	8								LEAN CLAY (CL), very stiff, olive brown, moist, few wood fragments and organic debris; PP=2.0 tsf					PP=0.5 tsf
											S2	12		
									SILTY SAND (SM), medium dense, grayish brown, moist, mostly fine- to medium-grained sand, little fines					Transition in sampler shoe.

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 2 of 6

Elevation, feet: 414, 412, 410, 408, 406, 404, 402, 400
Depth, feet: 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29

Elevation, feet	Depth, feet	ROCK CORE: Run No.	Box No.	Recovery, %	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES: Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
	13								SILTY SAND (SM), medium dense, grayish brown, moist, mostly fine- to medium-grained sand, little fines (continued)					
	14								WELL-GRADED SAND WITH SILT (SW-SM), medium dense, brown, moist, mostly fine- to coarse-grained sand, few fines					Recover 4 inches.
									SILTY CLAY (CL-ML), medium stiff, gray, very moist		S3	10		
	18								WELL-GRADED GRAVEL WITH SAND (GW), very dense, brown, very moist, mostly fine to coarse gravel, some fine- to coarse-grained sand, trace fines, few cobbles					
											S4	76		Disturbed sample. PA: 4%<#200
									SANDY FAT CLAY (CH), medium stiff, gray, moist, some fine-grained and trace medium-grained sand, few fine gravel					Driller adds casing to stabilize hole. PP=0.5 tsf
											S5	4		PA: 61%<#200 LL=60, PI=33

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

NOTES:
1. SEE SHEET G-1 FOR LOCATION OF EXPLORATION.
2. SEE SHEET G-2 FOR KEYS TO SYMBOLS.
3. SEE SHEETS G-24 AND G-25 FOR THE REMAINING LOG INFORMATION.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER MAINSTEM
LOWER SANTA ANA RIVER CHANNEL, REACH 9
BNSF RAILROAD BRIDGE PROTECTION
RIVERSIDE COUNTY, CALIFORNIA

LOG OF BORING URS B-20
SHEETS 1 AND 2 OF 6 SHEETS

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

DESIGNED BY: MGS
DRAWN BY: URS/EH
CHECKED BY: MGS/PRB

URS
999 TOWN & COUNTRY RD
ORANGE, CA 92868

SUBMITTED BY:
JAMES A. FARLEY, PE
CHIEF, GEOTECHNICAL BRANCH

FILE NAME: GBNSF_PS23.DGN
SPEC. NO. W912PL-17-R-0046
DISTRICT FILE NO. 239/3864

Scale: AS SHOWN
SHEET
G-23

VIEW: SHEET SPACE VIEW

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 3 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
398	29								SANDY FAT CLAY (CH), medium stiff, gray, moist, some fine-grained and trace medium-grained sand, few fine gravel (continued)					
	30								Becomes stiff, very moist SILTY SAND (SM), dense, grayish brown, very moist, mostly fine- to coarse-grained sand, little fines		S6	38		PP=1.5 tsf
396	31													
	32													
394	33													
	34								POORLY GRADED SAND WITH SILT AND GRAVEL (SP-SM), very dense, grayish brown, very moist, mostly fine- to medium-grained and few coarse-grained sand, some fine to coarse gravel, few fines					
392	35										S7	49		PA: 8%<#200
	36													
390	37													
	38													
388	39								WELL-GRADED GRAVEL (GW), very dense, grayish brown, moist, fine to coarse gravel, trace medium- to coarse-grained sand					
	40										S8	69		Disturbed sample. PA: 0%<#200
386	41													
	42													
384	43								WELL-GRADED SAND WITH GRAVEL (SW), very dense, brown, moist, mostly fine- to coarse-grained sand, some fine to coarse gravel, trace fines					
	44													
	45													

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 4 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
382	45								WELL-GRADED SAND WITH GRAVEL (SW), very dense, brown, moist, mostly fine- to coarse-grained sand, some fine to coarse gravel, trace fines (continued)		S9	56		PA: 5%<#200
	46								LEAN CLAY (CL), gray, very moist					
380	47													
	48								POORLY GRADED SAND WITH GRAVEL (SP), very dense, brown, moist, mostly fine- to medium-grained and few coarse-grained sand, little fine to coarse gravel, trace fines					
378	49													
	50										S10	92/ 11"		PA: 4%<#200 M=9.0% DD=121.0 pcf
376	51								WELL-GRADED SAND WITH GRAVEL (SW), very dense, brown, moist, mostly fine- to coarse-grained sand, little fine to coarse gravel, trace fines					PA: 4%<#200 M=8.5% DD=100.3 pcf
	52													
374	53								WELL-GRADED GRAVEL WITH SAND (GW), very dense, brown, moist, mostly fine to coarse gravel, some fine- to coarse-grained sand, trace fines					
	54													
372	55										S11	58		Recover 4 inches. PA: 3%<#200
	56													
370	57													Poor circulation 55-70 ft.
	58								WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM), very dense, brown, moist, mostly fine to coarse gravel, some fine- to coarse-grained sand, few fines, few cobbles					
368	59													
	60								Increase in gravel content and size		S12	81		PA: 10%<#200 M=9.8% DD=114.1 pcf
	61													

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

NOTES:
1. SEE SHEET G-1 FOR LOCATION OF EXPLORATION.
2. SEE SHEET G-2 FOR KEYS TO SYMBOLS.

MICHAEL G. SMITH
No. 2229
Exp. 3-31-18

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER MAINSTEM
LOWER SANTA ANA RIVER CHANNEL, REACH 9
BNSF RAILROAD BRIDGE PROTECTION
RIVERSIDE COUNTY, CALIFORNIA

LOG OF BORING URS B-20
SHEETS 3 AND 4 OF 6 SHEETS

DESIGNED BY: MGS
DRAWN BY: URS/EH
CHECKED BY: MGS/PRB
FILE NAME: GBNSF_PS24.DGN

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

URS
999 TOWN & COUNTRY RD
ORANGE, CA 92868

SUBMITTED BY:
JAMES A. FARLEY, PE
CHIEF, GEOTECHNICAL BRANCH

SPEC. NO. W912PL-17-R-0046
DISTRICT FILE NO. 239/3865

Scale: AS SHOWN
SHEET
G-24

VIEW: SHEET SPACE VIEW

MICHAEL G. SMITH
No. 2229
Exp. 3-31-18

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 5 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
366	61								WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM), very dense, brown, very moist, mostly fine to coarse gravel, some fine- to coarse-grained sand, few fines, few cobbles (continued)		S12	81		PA: 10%<#200 M=6.2% DD=134.6 pcf
	62													
364	63								WELL-GRADED GRAVEL WITH SAND (GW), very dense, brown, brown, very moist, mostly fine to coarse gravel, some fine- to coarse-grained sand, trace fines					
	64													
362	65										S13	84/9"		PA: 4%<#200
	66				NA				WELL-GRADED SAND WITH GRAVEL (SW), brown, wet, mostly fine- to coarse-grained sand, little fine to coarse gravel, trace fines, few cobbles				1443	Start HQ-3 coring.
360	67		1		NA									No core recovery 67.6-70.0 ft; sand and fines washed out.
	68	1		31	NA	NA							[53]	
358	69				NA		NR						1447	
	70				NA								1458	No core recovery 70.0-72.0 ft.
356	71	2		0	NA	NA	NR						[12] 1508	
	72				NA								0900	End for 5/29/12. Resume drilling on 5/31/12 No core recovery 72.8-77.0 ft.
354	73				NA									
	74	3		16	NA	NA	NR		SANDSTONE, dark reddish brown, fine- to coarse-grained, massive, completely weathered, extremely weak, trace gravel **[SESPE-VAQUEROS FORMATION]**				[21]	Drill fluid turns reddish brown, possible start of bedrock.
352	75				NA									
	76				NA								0914	
	77													

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

Project: BNSF Railroad Bridge - LSAR Bank Protection - Reach 9
Project Location: Corona, California
Project Number: 29871609

Log of Boring URS B-20

Sheet 6 of 6

Elevation, feet	Depth, feet	ROCK CORE Run No.	Box No.	Recovery,%	Fractures per Foot	R Q D, %	Fracture Drawing Number	Lithology	MATERIAL DESCRIPTION	SOIL SAMPLES Type	Number	Blows / 6 in.	Drill Time [Rate, ft/hr]	FIELD NOTES AND TEST RESULTS
350	77		1		0				SANDSTONE, dark reddish brown, fine- to coarse-grained, massive, completely weathered, extremely weak, trace gravel (continued)				0924	
	78				0									
348	79	4		80	0	0							[33]	
	80				0									
346	81				NA		NR						0933	No core recovery 81.0-82.0 ft.
	82				3		1 1 1		1: 60°, B, T-MW, Cl, Fi, Pl, S-SR Very thinly bedded				0944	
344	83				0				Becomes mostly fine- to medium-grained, some fine to coarse gravel, few cobbles					
	84	5		44	NA	0							[-9]	No core recovery 84.2-87.0 ft.
342	85				NA		NR							
	86				NA								0909	
340	87				0				Few gravel, trace cobbles				1010	
	88				0									
338	89	6		64	0	0			Zone of fine to coarse subrounded gravel				[23]	
	90				NA									No core recovery 90.2-92.0 ft.
336	91				NA		NR						1023	
	92								**TOTAL DEPTH = 92.0 FEET**					Terminate drilling on 5/31/12.
	93													

Report: GEO_CORE+SOIL_17LA; File: SNA_BNSFBRIDGE.GPJ; 2/5/2014 B-20

URS

NOTES:

1. SEE SHEET G-1 FOR LOCATION OF EXPLORATION.
2. SEE SHEET G-2 FOR KEYS TO SYMBOLS.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL

REVISIONS

SANTA ANA RIVER MAINSTEM
LOWER SANTA ANA RIVER CHANNEL, REACH 9
BNSF RAILROAD BRIDGE PROTECTION
RIVERSIDE COUNTY, CALIFORNIA

LOG OF BORING URS B-20
SHEETS 5 AND 6 OF 6 SHEETS

DESIGNED BY: MGS
DRAWN BY: URS/EH
CHECKED BY: MGS/PRB
FILE NAME: GBNSF_PS25.DGN

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS

SUBMITTED BY:
JAMES A. FARLEY, PE
CHIEF, GEOTECHNICAL BRANCH

SPEC. NO. W912PL-17-R-0046

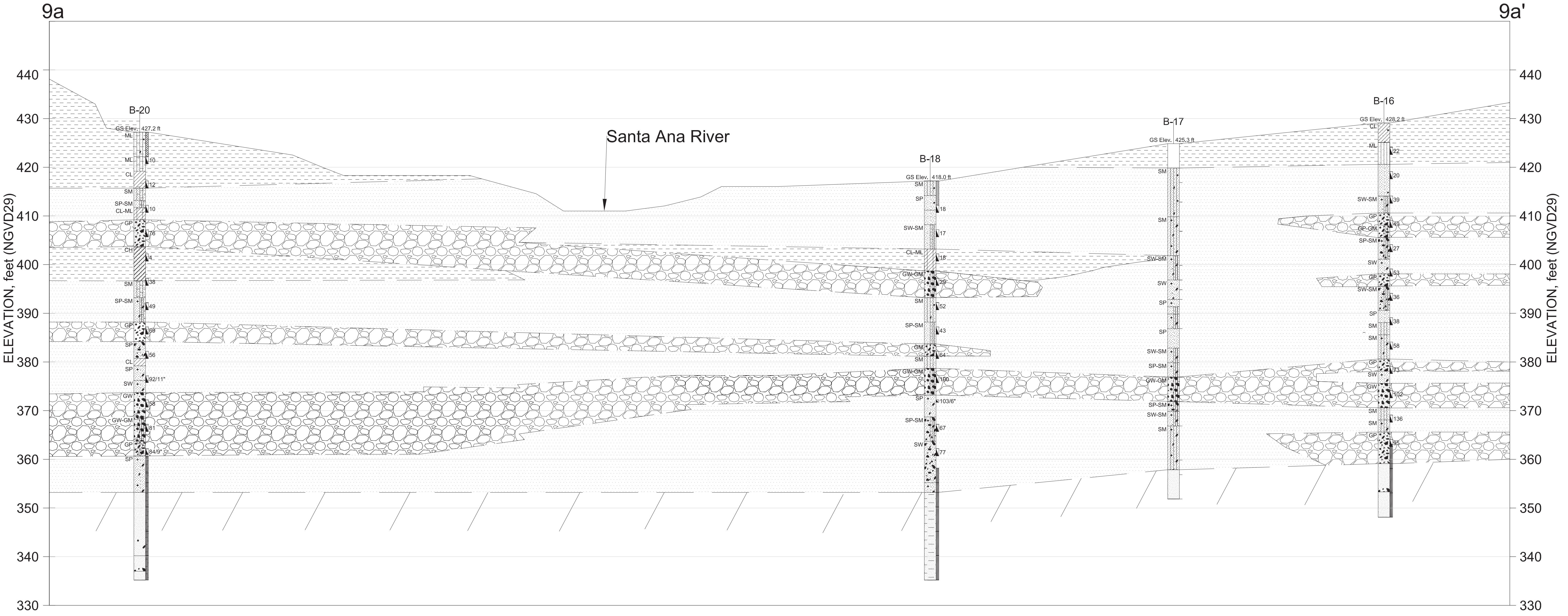
URS
999 TOWN & COUNTRY RD
ORANGE, CA 92868

DISTRICT FILE NO. 239/3866

Scale: AS SHOWN

SHEET
G-25

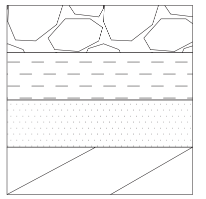
VIEW: SHEET SPACE VIEW

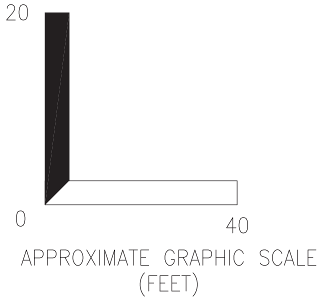


Note: Refer to Figure 6 for section location

"Looking Northeast and upstream along Santa Ana river"

Legend

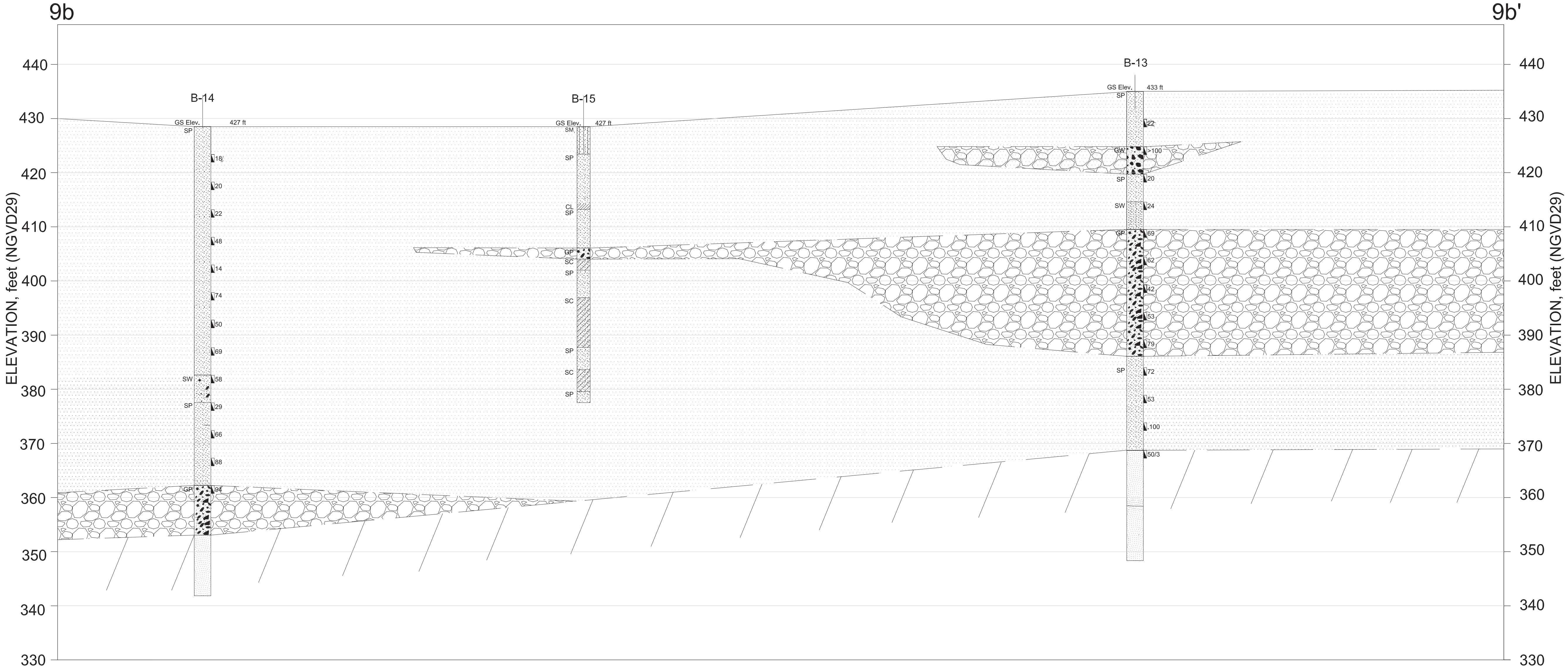




GEOLOGIC CROSS SECTION 9a-9a'
BNSF SANTA ANA RIVER BRIDGES

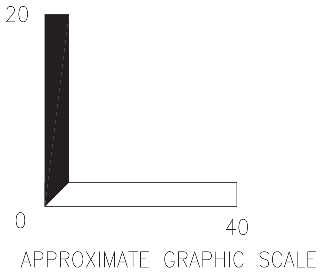
URS

CHECKED BY: CWG	DATE: 08-01-16	FIG. NO:
PM: MGS	PROJ. NO: 29871609.00004	9a



Note: Refer to Figure 6 for section location

"Looking Northeast and upstream along Santa Ana river"



APPROXIMATE GRAPHIC SCALE
(FEET)

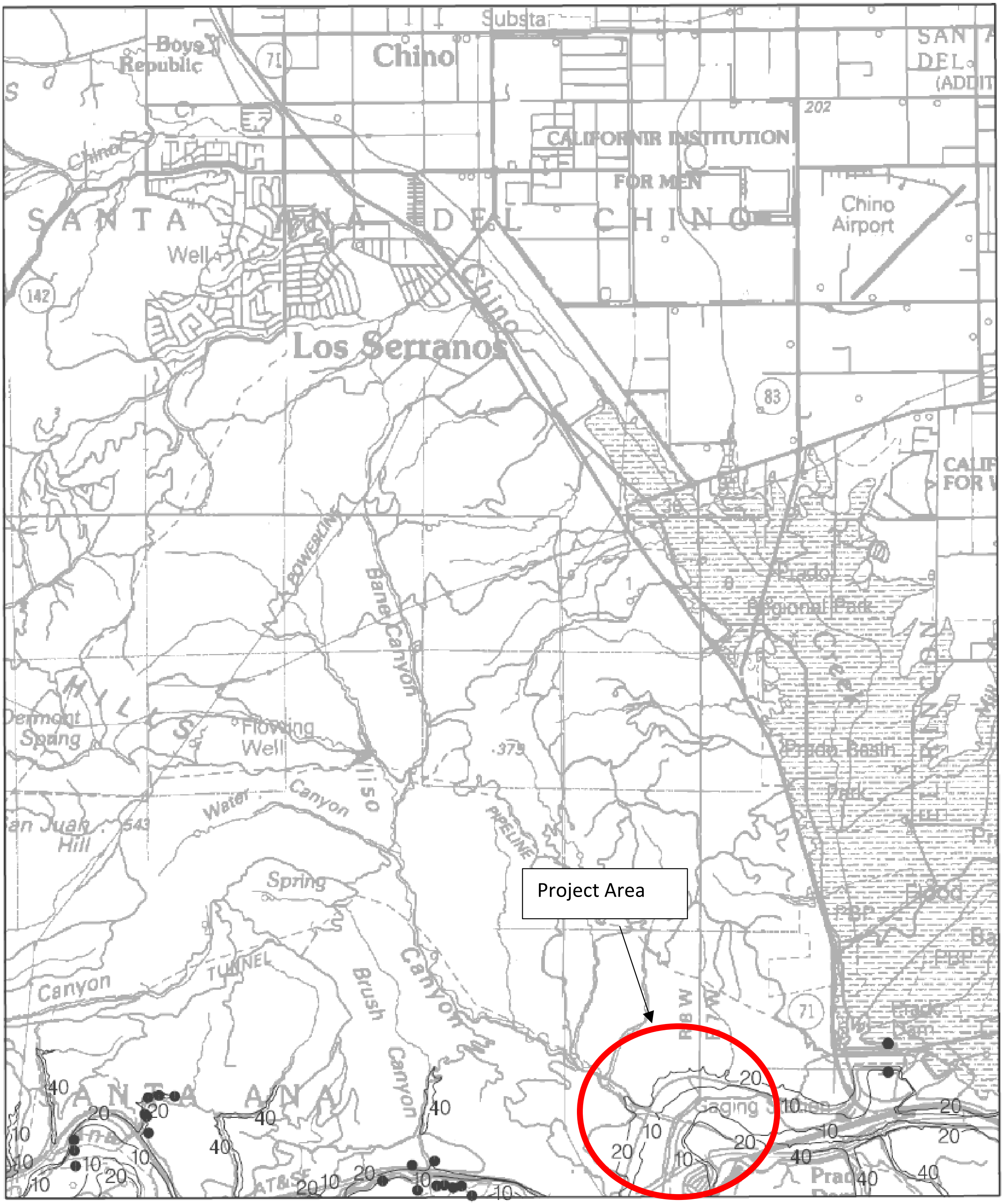
Legend

▨ Gravel
░ Sand
▧ Bedrock

GEOLOGIC CROSS SECTION 9b-9b'
BNSF SANTA ANA RIVER BRIDGES

URS	CHECKED BY: CWG	DATE: 08-01-16	FIG. NO:
	PM: MGS	PROJ. NO: 29871609.00004	9b

APPENDIX C -
HISTORICALLY HIGHEST GROUNDWATER LEVEL



Project Area

Base map enlarged from U.S.G.S. 30 x 60–minute series

Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Prado Dam Quadrangle.

● Borehole Site

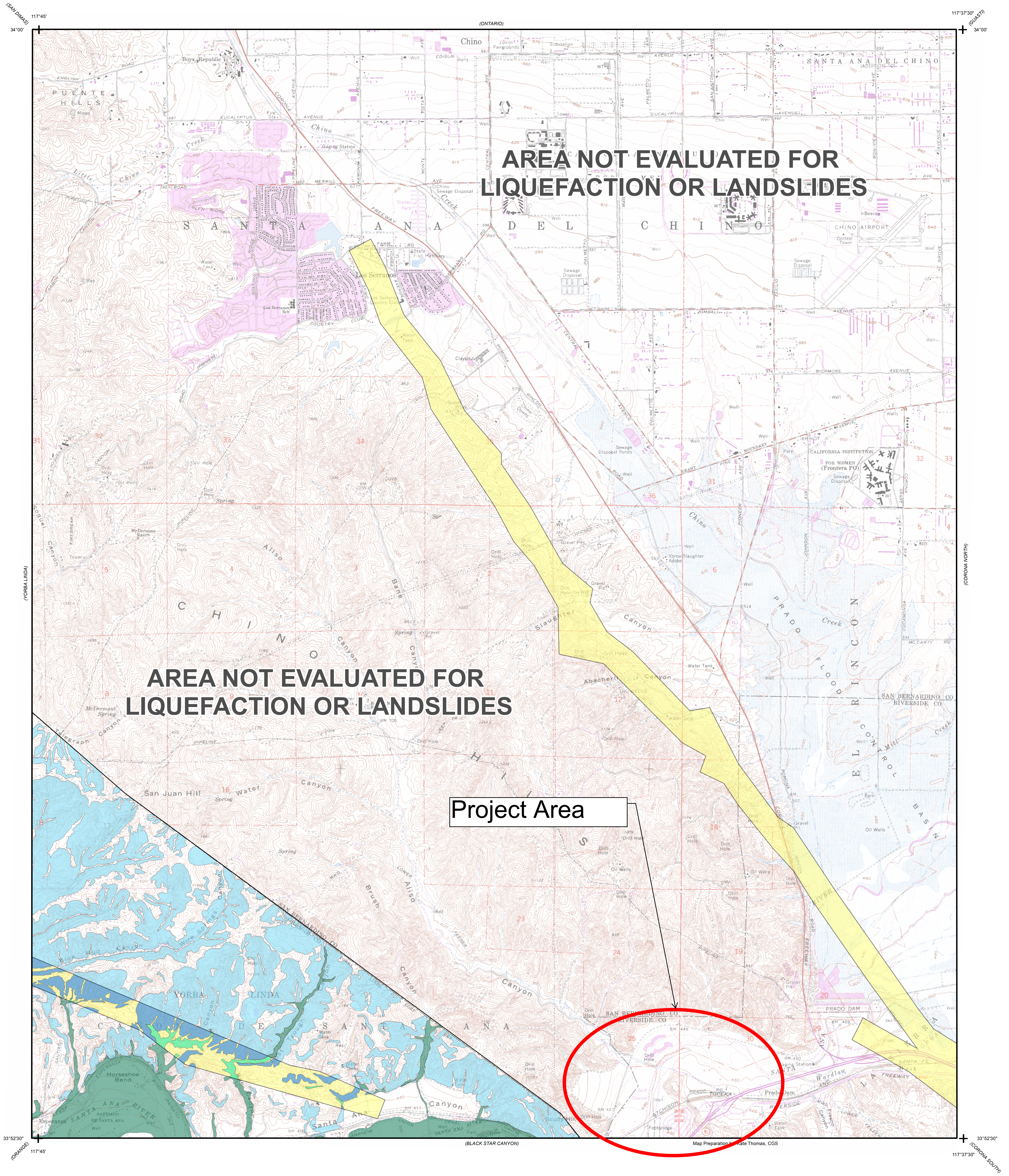
30 Depth to ground water in feet

APPENDIX D -
ALQUIST PRIOLO FAULT MAP

CALIFORNIA GEOLOGICAL SURVEY
JOHN G. PARRISH, PHD., STATE GEOLOGIST

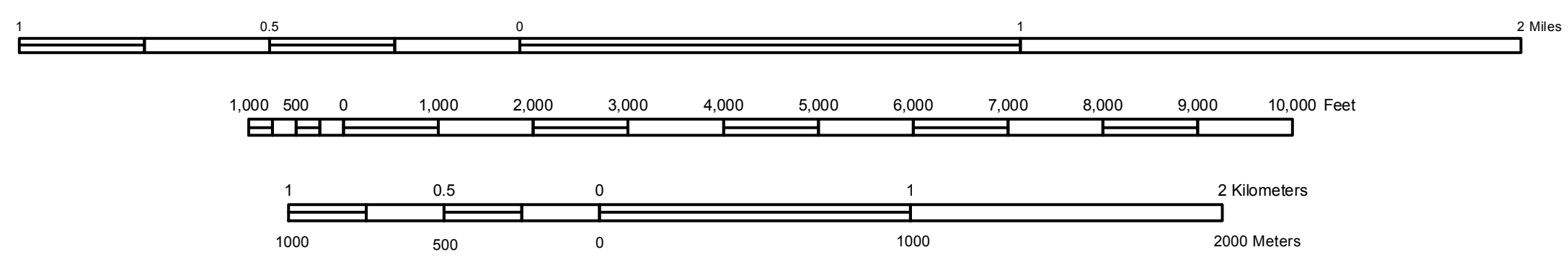
STATE OF CALIFORNIA - EDMUND G. BROWN, JR., GOVERNOR
THE NATURAL RESOURCES AGENCY- JOHN LAIRD, SECRETARY
DEPARTMENT OF CONSERVATION - DAVID BUNN, DIRECTOR

EARTHQUAKE FAULT ZONES AND SEISMIC HAZARD ZONES
PRADO DAM 7.5 MINUTE QUADRANGLE

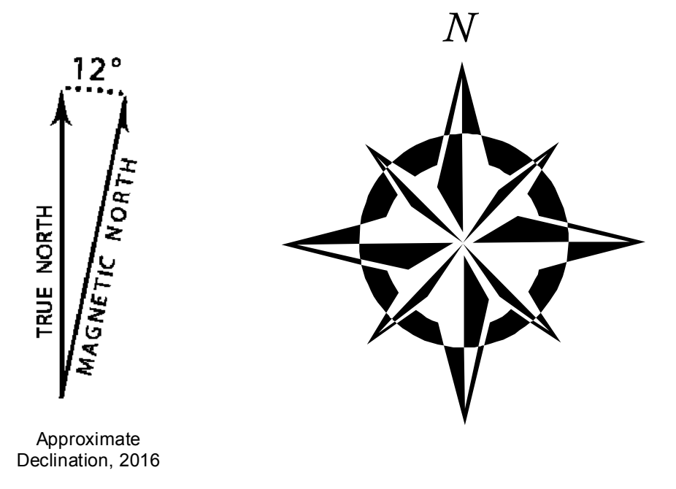


Study area defined by USGS quadrangle boundaries using NAD 27, represented by the visible map extent. Data are maintained and distributed in California Albers (meters), NAD 83, [EPSG:3310] as shown by tics and coordinates.
Shaded topographic relief derived from USGS 10 meter NED, 2013.
Topographic base map from USGS 1967, photorevised, 1981.
Street data from US Census Bureau TIGER/Line, 2016.

Scale 1: 24000

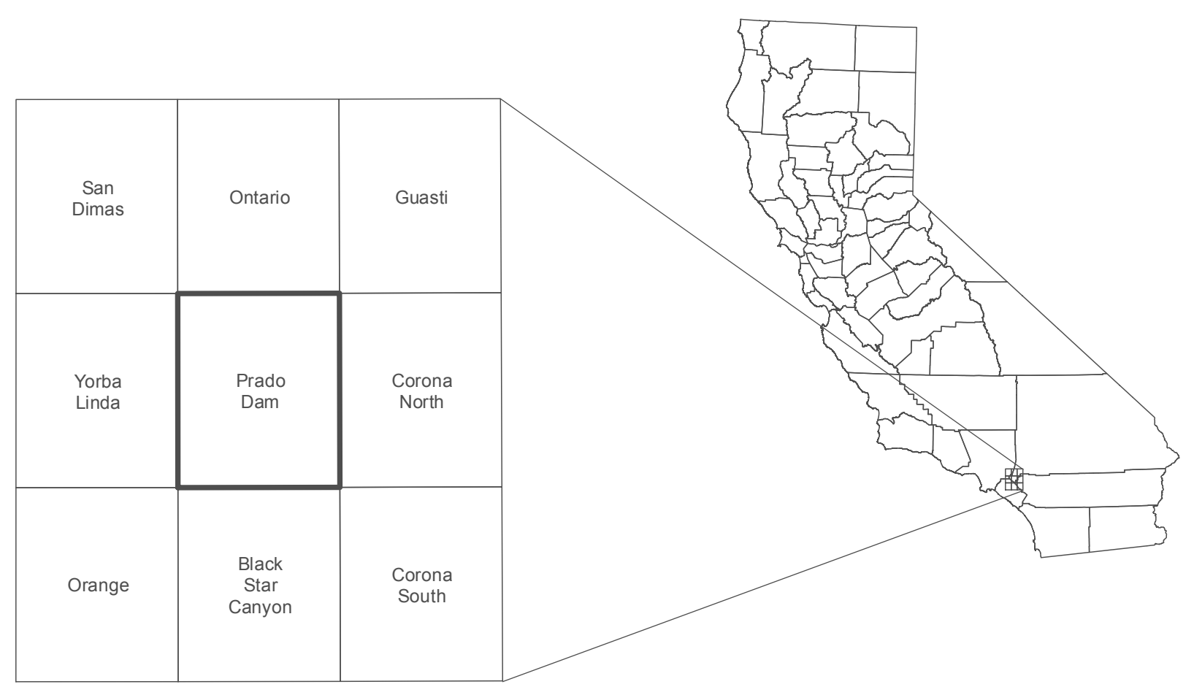


Contour Interval 25 Feet



Approximate
Declination, 2016

California Geological Survey
Geologic Information and Publications
801 K Street, MS 14-34
Sacramento, CA 95814-3532
www.conservation.ca.gov/cgs



Earthquake Zones of Required Investigation Prado Dam Quadrangle

California Geological Survey

This Map Shows Both Alquist-Priolo Earthquake Fault Zones And Seismic Hazard Zones Issued For The Prado Dam Quadrangle

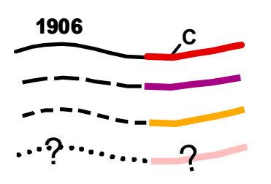
This map shows the location of Alquist-Priolo (AP) Earthquake Fault Zones and Seismic Hazard Zones, collectively referred to here as Earthquake Zones of Required Investigation. The Geographic Information System (GIS) digital files of these regulatory zones released by the California Geological Survey (CGS) are the "Official Maps." GIS files are available at the CGS website http://maps.conservation.ca.gov/cgs/informationwarehouse/. These zones will assist cities and counties in fulfilling their responsibilities for protecting the public from the effects of surface fault rupture and earthquake-triggered ground failure as required by the AP Earthquake Fault Zoning Act (Public Resources Code Sections 2621-2630) and the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6). For information regarding the general approach and recommended methods for preparing these zones, see CGS Special Publication 42, *Earthquake Fault Zones, a Guide for Government Agencies, Property Owners/Developers, and Geoscience Practitioners for Assessing Fault Rupture Hazards in California,* Appendix C, and CGS Special Publication 118, *Recommended Criteria for Delineating Seismic Hazard Zones in California*.

For information regarding the scope and recommended methods to be used in conducting required site investigations refer to CGS Special Publication 42, and CGS Special Publication 117A, *Guidelines for Evaluating and Mitigating Seismic Hazards in California*. For a general description of the AP and Seismic Hazards Mapping acts, the zonation programs, and related information, please refer to the website at www.conservation.ca.gov/cgs/.

MAP EXPLANATION

EARTHQUAKE FAULT ZONES

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments; the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required.



Active Fault Traces
Faults considered to have been active during Holocene time and to have potential for surface rupture: Solid Line in Black or Red where Accurately Located; Long Dash in Black or Solid Line in Purple where Approximately Located; Short Dash in Black or Solid Line in Orange where Inferred; Dotted Line in Black or Solid Line in Rose where Concealed; Query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

SEISMIC HAZARD ZONES

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

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

OVERLAPPING EARTHQUAKE FAULT AND SEISMIC HAZARD ZONES

Overlap of Earthquake Fault Zone and Liquefaction Zone
Areas that are covered by both Earthquake Fault Zone and Liquefaction Zone.

Overlap of Earthquake Fault Zone and Earthquake-Induced Landslide Zone
Areas that are covered by both Earthquake Fault Zone and Earthquake-Induced Landslide Zone.

Note: Mitigation methods differ for each zone –
AP Act only allows avoidance; Seismic Hazard Mapping Act allows mitigation by engineering/geotechnical design as well as avoidance.

ADDITIONAL INFORMATION

For additional information on the zones of required investigation presented on this map, the data and methodology used to prepare them, and additional references consulted, please refer to the following:

The Chino Fault, in the Prado Dam Quadrangle, Riverside and San Bernardino counties, California.
California Geological Survey, Fault Evaluation Report FER-247.
http://gmw.conservation.ca.gov/SHP/EZRIM/Reports/FER/247/

The Elsinore Fault Zone Fault, in the Prado Dam Quadrangle, in Riverside County, California.
California Geological Survey, Fault Evaluation Report FER-72.
http://gmw.conservation.ca.gov/SHP/EZRIM/Reports/FER/072/

The Whittier Fault, in the Prado Dam, Yorba Linda, La Habra, and Whittier Quadrangles, in Orange, Los Angeles, and San Bernadino counties, California. California Geological Survey, Fault Evaluation Report FER-41.
http://gmw.conservation.ca.gov/SHP/EZRIM/Reports/FER/041/

For more information on the Alquist-Priolo Earthquake Fault Zoning Act please refer to:
http://www.conservation.ca.gov/cgs/rghm/ap/Pages/main.aspx

Seismic Hazard Zone Report for the Prado Dam 7.5-minute Quadrangle, Orange County, California.
California Geological Survey, Seismic Hazard Zone Report 045.
http://gmw.conservation.ca.gov/SHP/EZRIM/Reports/SHZR/SHZR_045_Prado_Dam.pdf

For more information on the Seismic Hazards Mapping Act please refer to:
http://www.conservation.ca.gov/cgs/shzp/Pages/SHMPpgminfo.aspx

Click the link below to learn how to take greater advantage of the GeoPDF format of this map after downloading.
http://gmw.conservation.ca.gov/SHP/EZRIM/Docs/TerragoUserGuide.pdf

PRADO DAM QUADRANGLE

EARTHQUAKE FAULT ZONES

Delineated in compliance with
Chapter 7.5 Division 2 of the California Public Resources Code
(Alquist-Priolo Earthquake Fault Zoning Act)

REVISED OFFICIAL MAP

Released: May 1, 2003

STATE GEOLOGIST

SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8 Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

OFFICIAL MAP

Released: January 17, 2001

STATE GEOLOGIST

IMPORTANT

PLEASE NOTE THE FOLLOWING FOR ZONES SHOWN ON THIS MAP

1) This map may not show all faults that have the potential for surface fault rupture, either within the Earthquake Fault Zones or outside their boundaries. Additionally, this map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landside failure will not uniformly affect the entire area zoned.

2) Boundaries of Earthquake Fault Zones, if included on this map, are based on interpreted Holocene-active fault traces.

3) The identification and location of these faults are based on the best available data. However, the quality of data used is varied. Traces have been depicted as accurately as possible at a map scale of 1:24,000.

4) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toes of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

5) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). Landslide hazard maps prepared by the USGS typically use experimental approaches to assess earthquake-induced and other types of landslide hazards. Although aspects of these new methodologies may be incorporated in future CGS seismic hazard zone maps, USGS maps should not be used as substitutes for these Official SEISMIC HAZARD ZONES maps.

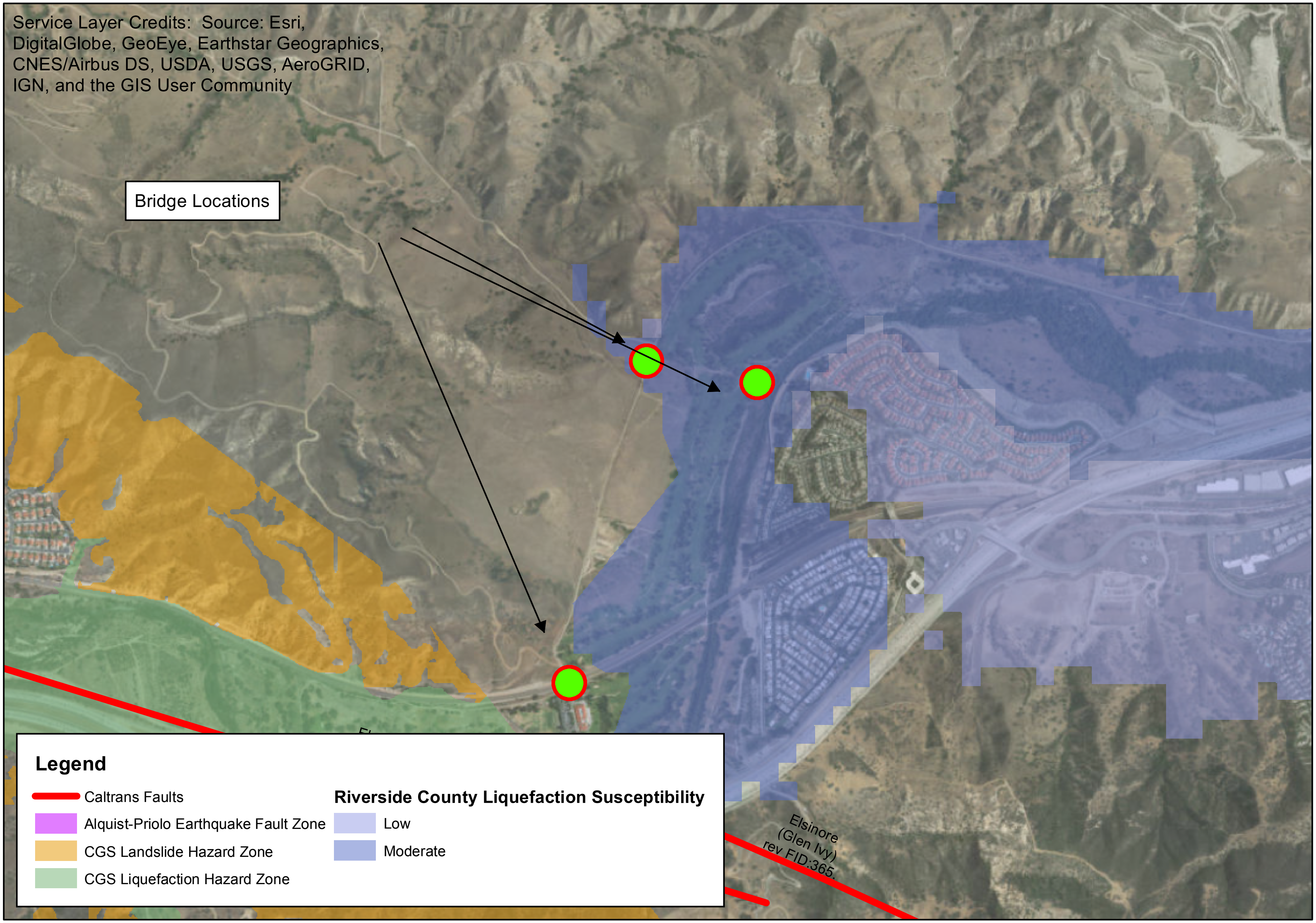
6) USGS base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

7) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the California Public Resources Code.

8) Seismic Hazard Zones identified on this map may include developed land where delineated hazards have already been mitigated to city or county standards. Check with your local building/planning department for information regarding the location of such mitigated areas.

9) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

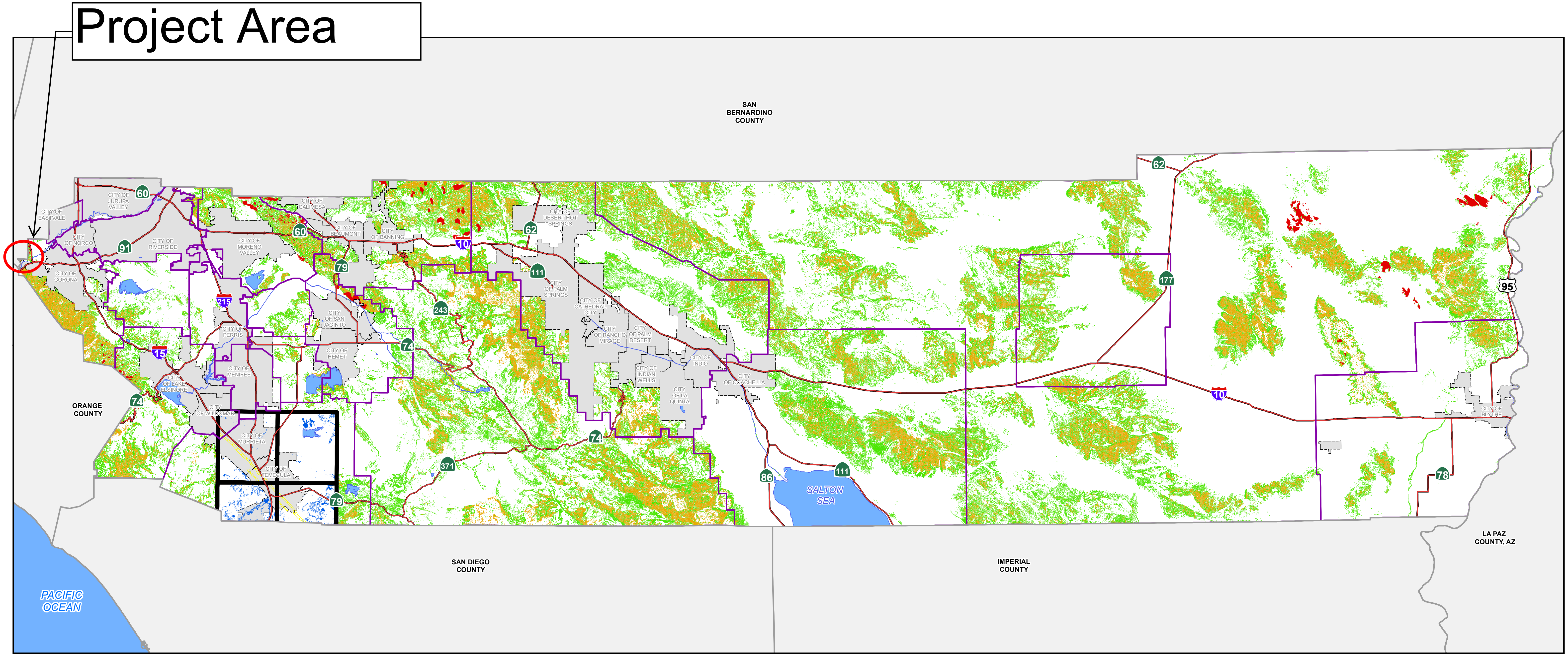
APPENDIX E -
LIQUEFACTION POTENTIAL MAP



Source: County of Riverside Open Data - Liquefaction (accessed 2017)
CGS, Prado Dam Quadrangle Seismic Hazards Zones Official Map (2001)
CGS, Black Star Canyon Quadrangle Seismic Hazards Zones Official Map (2001)
Caltrans Fault Database Version 2.0.06

Seismic Hazards Map

APPENDIX F -
LANDSLIDE SUSCEPTIBILITY MAP



Data Source: County Geology (2018)/California Geological Survey (2018)

Slope Instability

🟥 Existing Landslides

🟧 High susceptibility to seismically induced landslides and rockfalls.

🟩 Low to locally moderate susceptibility to seismically induced landslides and rockfalls.

Highways

Area Plan Boundary

City Boundary

Waterbodies

Seismic Hazard Zone Maps

Quadrangles

🟦 Earthquake Induced Landslide Zones

▨ Fault Zones

(See detail in Elsinore, Southwest, Sun City / Menifee Valley Area Plans)

Figure S-4

August 6, 2019

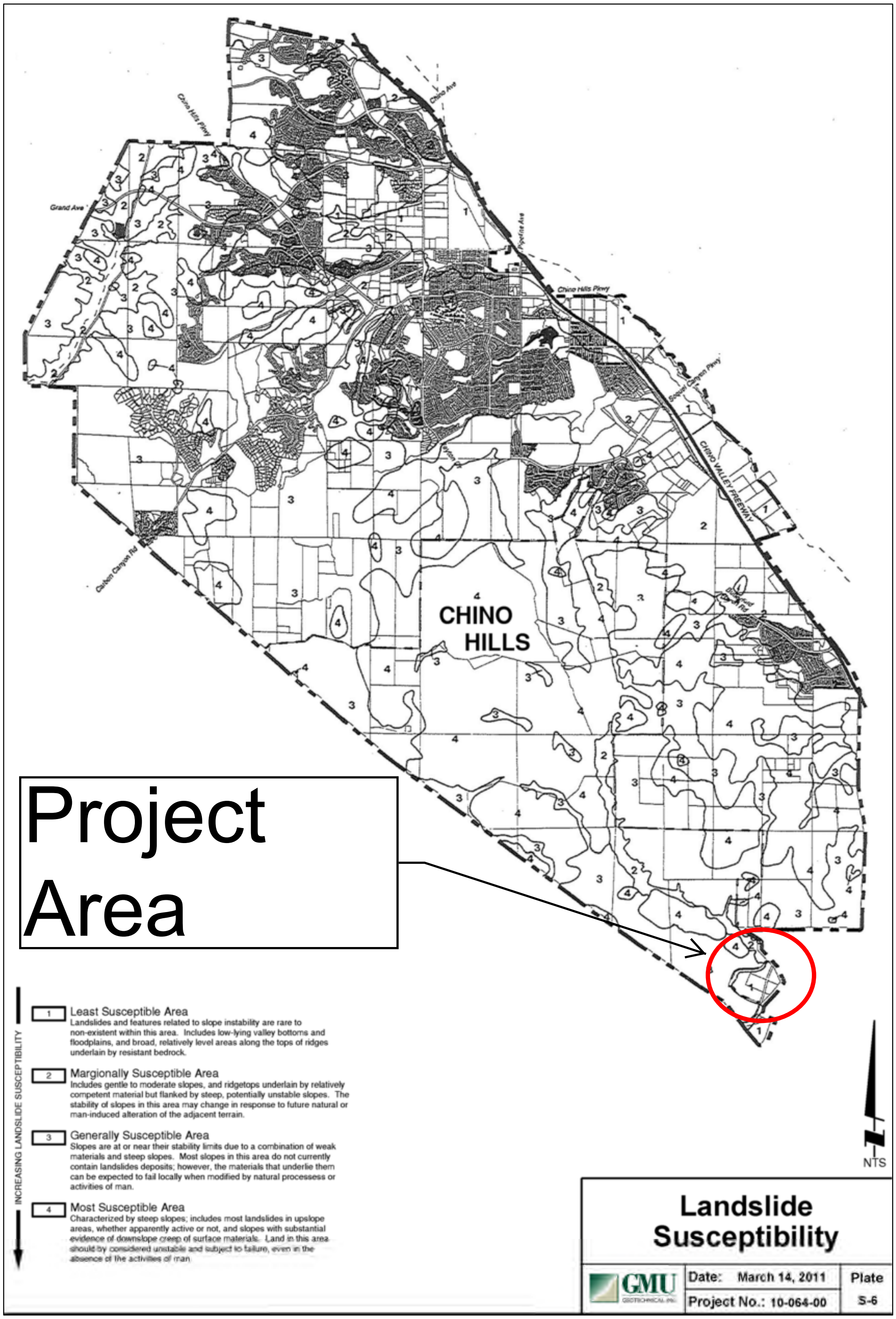
0 10 20 Miles

Disclaimer: Maps and data are to be used for reference purposes only. Map features are approximate, and are not necessarily accurate to surveying or engineering standards. The County of Riverside makes no warranty or guarantee as to the content (the source is often third party), accuracy, timeliness, or completeness of any of the data provided, and assumes no legal responsibility for the information contained on this map. Any use of this product with respect to accuracy and precision shall be the sole responsibility of the user.
Disclaimer: For information within a City or the March Air Reserve Base (MARB) boundary, refer to the Citye's or MARB's General Plan.

RIVERSIDE COUNTY PLANNING DEPARTMENT

EARTHQUAKE-INDUCED SLOPE INSTABILITY MAP

\agency\images\Projects\Planning\SafetyElement\Slope_Instability.mxd



1 **Least Susceptible Area**
Landslides and features related to slope instability are rare to non-existent within this area. Includes low-lying valley bottoms and floodplains, and broad, relatively level areas along the tops of ridges underlain by resistant bedrock.

2 **Margionally Susceptible Area**
Includes gentle to moderate slopes, and ridgetops underlain by relatively competent material but flanked by steep, potentially unstable slopes. The stability of slopes in this area may change in response to future natural or man-induced alteration of the adjacent terrain.

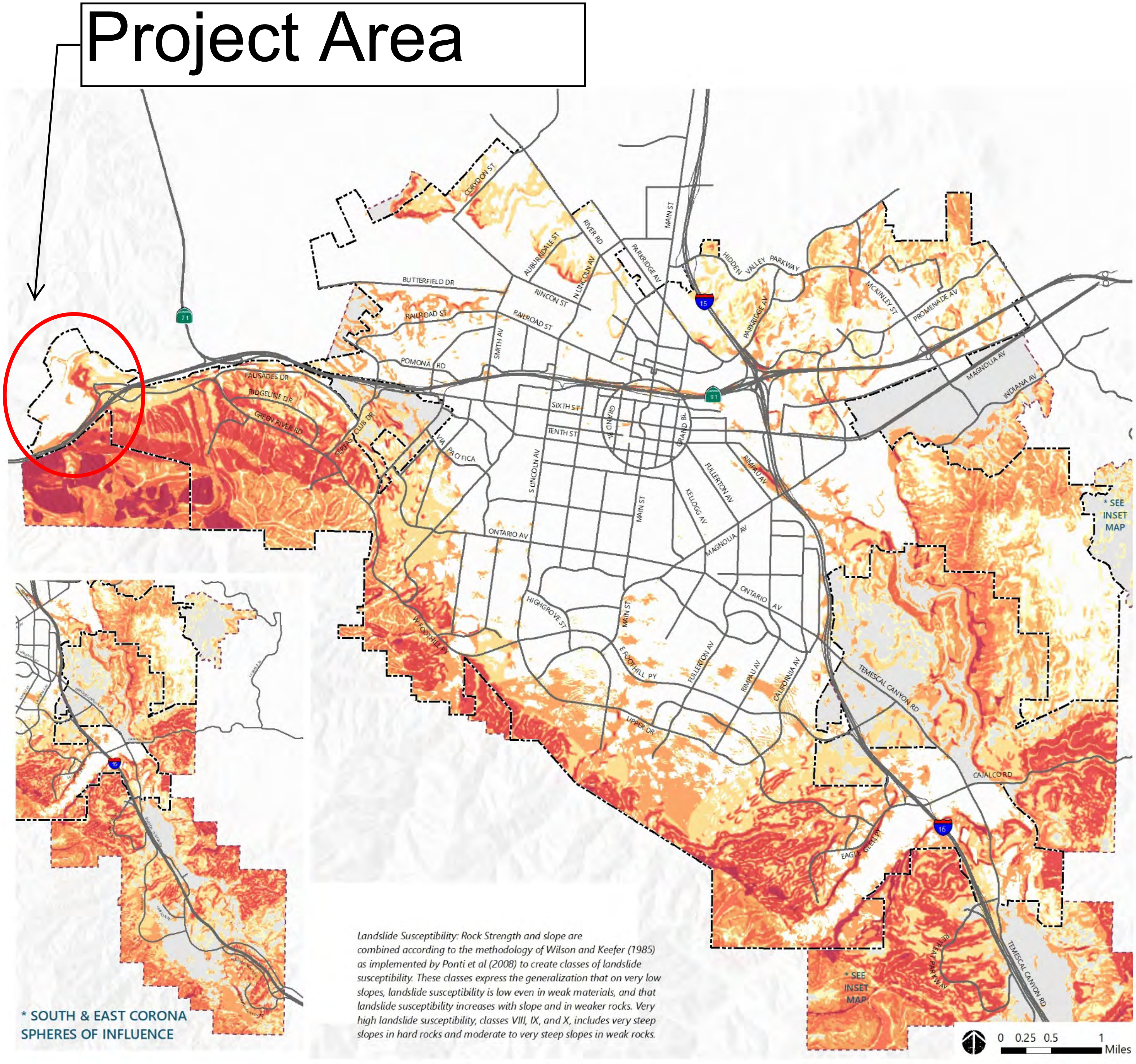
3 **Generally Susceptible Area**
Slopes are at or near their stability limits due to a combination of weak materials and steep slopes. Most slopes in this area do not currently contain landslides deposits; however, the materials that underlie them can be expected to fail locally when modified by natural processess or activities of man.

4 **Most Susceptible Area**
Characterized by steep slopes; includes most landslides in upslope areas, whether apparently active or not, and slopes with substantial evidence of downslope creep of surface materials. Land in this area should by considered unstable and subject to failure, even in the absence of the activities of man.

Landslide Susceptibility

Date: March 14, 2011
Project No.: 10-064-00
Plate S-6

Figure 5-5 – Landslide Susceptibility



Landslide Susceptibility: Rock Strength and slope are combined according to the methodology of Wilson and Keefer (1985) as implemented by Ponti et al (2008) to create classes of landslide susceptibility. These classes express the generalization that on very low slopes, landslide susceptibility is low even in weak materials, and that landslide susceptibility increases with slope and in weaker rocks. Very high landslide susceptibility, classes VIII, IX, and X, include very steep slopes in hard rocks and moderate to very steep slopes in weak rocks.

Figure PS-3
Landslide Hazards

Legend

⬚ City Boundary

▨ Sphere of Influence Areas

ROCK STRENGTH

SLOPE CLASS	1	2	3
1	0	0	0
2	0	V	VII
3	0	V	VII
4	III	VIII	IX
5	VI	IX	X
6	VII	IX	X
7	VIII	IX	X
8	VIII	IX	X

LANDSLIDE SUSCEPTIBILITY CLASSES

(0 III V VI VII VIII IX X)

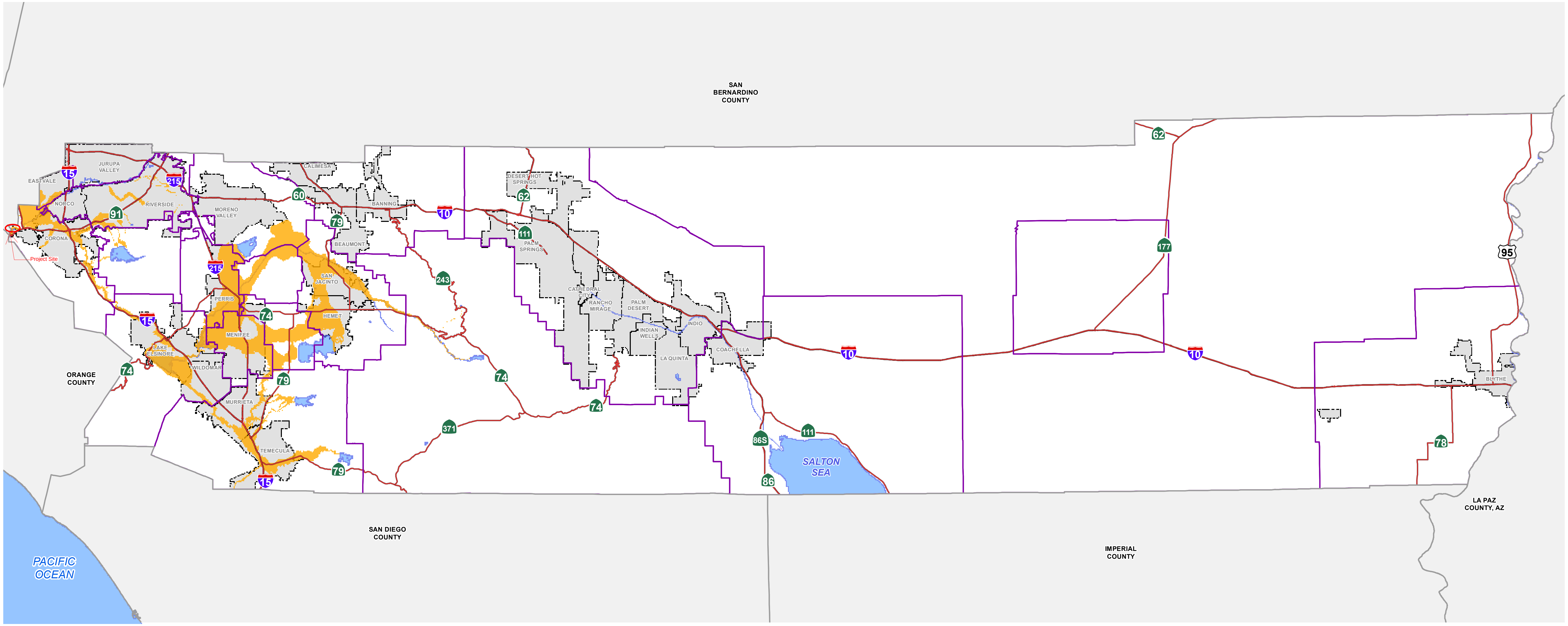
increasing susceptibility

Source:
Deep-Seated Landslide Susceptibility (CGS Map Sheet 58) C.J. Wills, F.G. Perez, C. I. Gutierrez- California Geological Survey, 2011

For more information please see:
http://www.conservation.ca.gov/cgs/information/publications/ms/documents/ms58.pdf

CORONA General Plan

APPENDIX G -
DAM HAZARD MAP



Data Source: State of California Office of Emergency Services (2003) and Riverside County (2006)

Dam Hazard Zones

●	Dam Hazard Zones
∼	Highways
○	Area Plan Boundary
▨	City Boundary
●	Waterbodies

\agency\images\Projects\Planning\Safety_Element\Dam_Inundations.mxd

Figure S-10

December 8, 2015

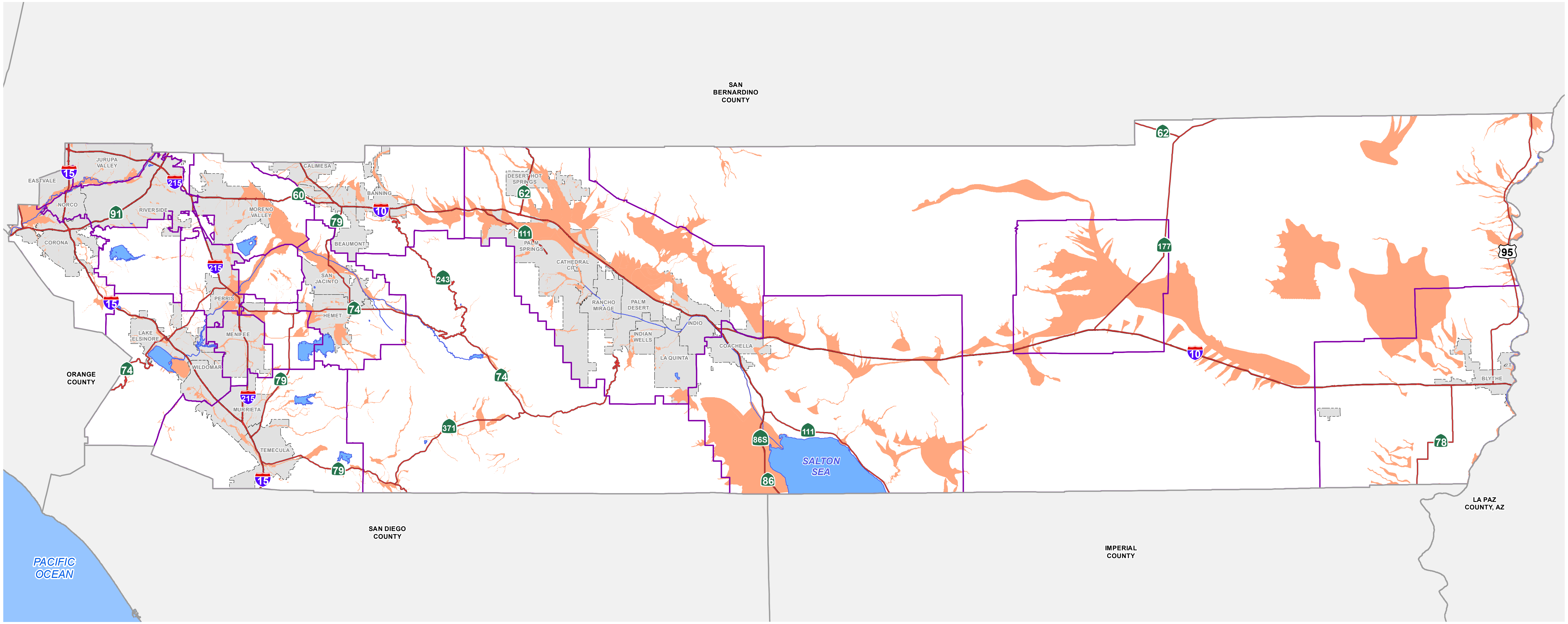
0 10 20 Miles

Disclaimer: Maps and data are to be used for reference purposes only. Map features are approximate, and are not necessarily accurate to surveying or engineering standards. The County of Riverside makes no warranty or guarantee as to the content (the source is often third party), accuracy, timeliness, or completeness of any of the data provided, and assumes no legal responsibility for the information contained on this map. Any use of this product with respect to accuracy and precision shall be the sole responsibility of the user.

RIVERSIDE COUNTY PLANNING DEPARTMENT

DAM FAILURE INUNDATION ZONES

APPENDIX H -
FLOODING AND INUNDATION MAP



Data Source: Riverside County Flood Control (2015)

Special Flood Hazard Areas

Highways

Area Plan Boundary

City Boundary

Waterbodies

Disclaimer:
The Public Flood Hazard Determination Interactive Map incorporates all of the Special Flood Hazard Areas in the unincorporated County of Riverside as listed in Ordinance No. 458.14 Section 5. It is updated quarterly to include any amendments, revisions or additions thereto that go into effect pursuant to Federal Law, and those that are adopted by resolution by the Board of Supervisors of the County of Riverside after a public hearing.

The flood hazard information is believed to be accurate and reliable. Flood heights and boundaries may be increased by man-made or natural causes. Moreover, this Interactive Map does not imply that land outside the regulated areas or the uses and development permitted within such areas will be free from flooding or flood damages. It is the duty and responsibility of CVWD and RCFC&WCD to make interpretations, where needed, as to the exact location of the boundaries of the special flood hazard areas and whether a property is governed by Ordinance 458.
Decisions made by the user based on this Interactive Map are solely the responsibility of the user. RCFC&WCD and CVWD assume no responsibility for any errors and are not liable for any damages of any kind resulting from the use of, or reliance on, the information contained herein without first consulting the respective flood control agency with jurisdiction. If the property of interest is close to a floodplain, users are advised to contact the appropriate flood control agency for additional information and to obtain information regarding building requirements.

Figure S-9

December 8, 2015

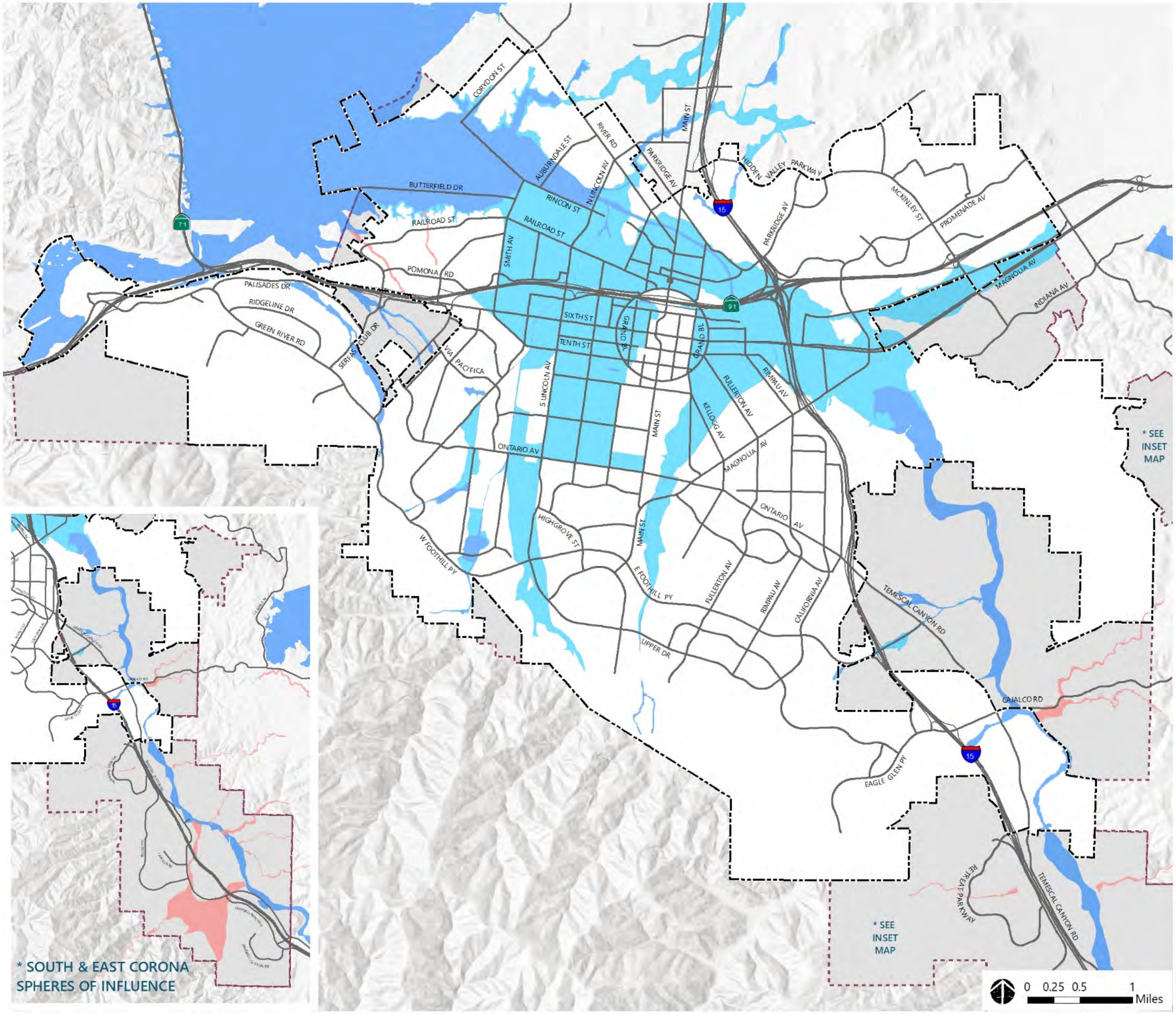
0 10 20 Miles

Disclaimer: Maps and data are to be used for reference purposes only. Map features are approximate, and are not necessarily accurate to surveying or engineering standards. The County of Riverside makes no warranty or guarantee as to the content (the source is often third party), accuracy, timeliness, or completeness of any of the data provided, and assumes no legal responsibility for the information contained on this map. Any use of this product with respect to accuracy and precision shall be the sole responsibility of the user.

RIVERSIDE COUNTY PLANNING DEPARTMENT

SPECIAL FLOOD HAZARD AREAS

Figure PS-5
Flood Hazards



Legend

🟦 100-Year Flood Zone

🟦 500-Year Flood Zone

🟥 DWR Awareness Floodplain

⬚ City Boundary

▨ Sphere of Influence Areas

Notes:

100-year flood zone: Includes areas subject to a 100-year flood as defined by FEMA. This area is also referred to as a special flood harard area.

500-year flood zone: Includes areas between the limits of the 100-year floodplain and subject to a 500-year flood as defined by FEMA. This area is also referred to as a moderate flood hazard area.

DWR Awareness flood zone: Includes areas defined by the California DWR with a potential for a 100-year flood that may warrant further study to assess the risk of flooding.

This map does not have the official status

Source:
Department of Water Resources (DWR, 2016)
Federal Emergency Management Agency (FEMA, 2016)

CORONA
General Plan

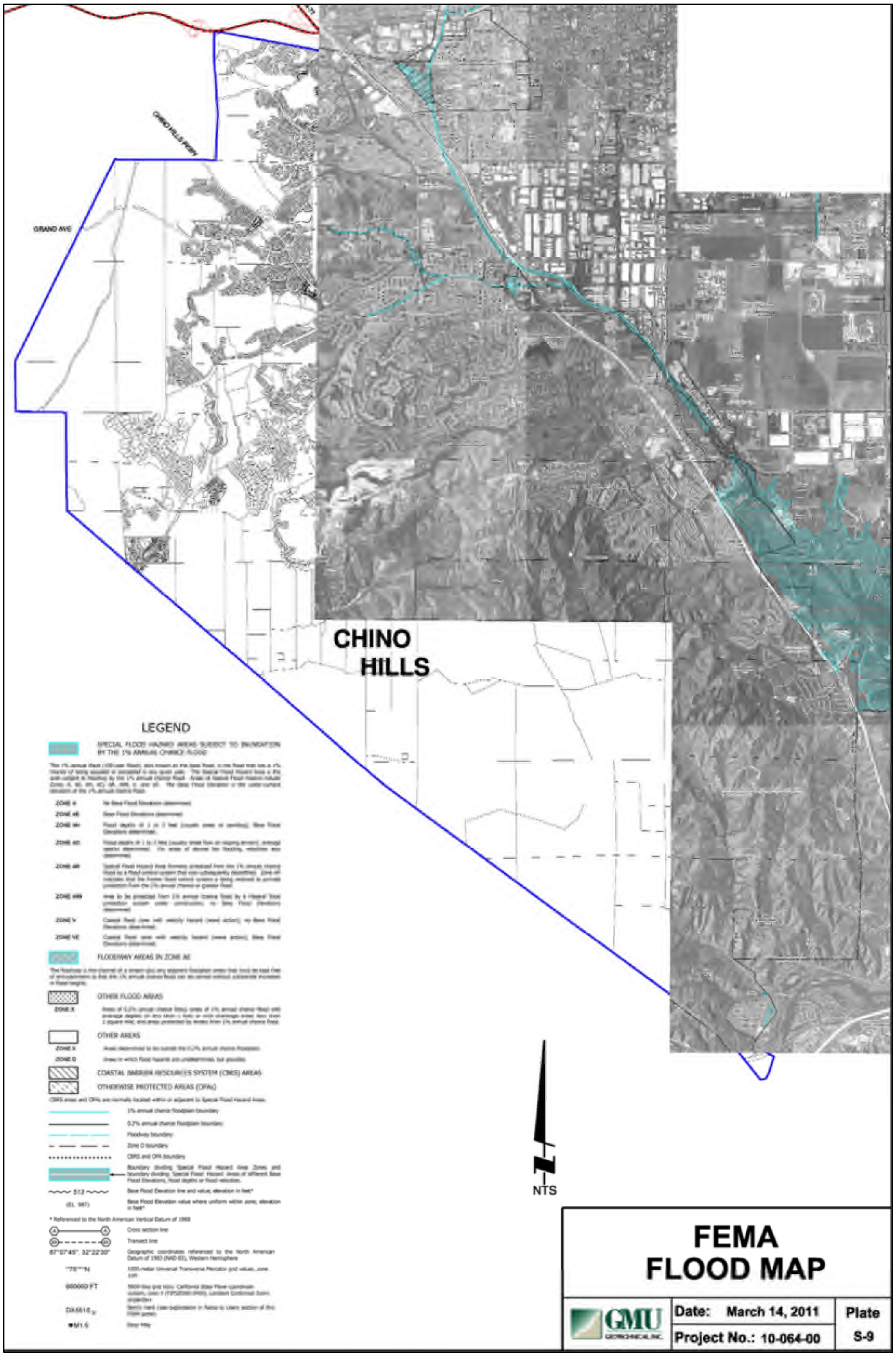


Figure 5-8– FEMA Flood Map

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 11. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from the National Agriculture Imagery Program, dated 2005.

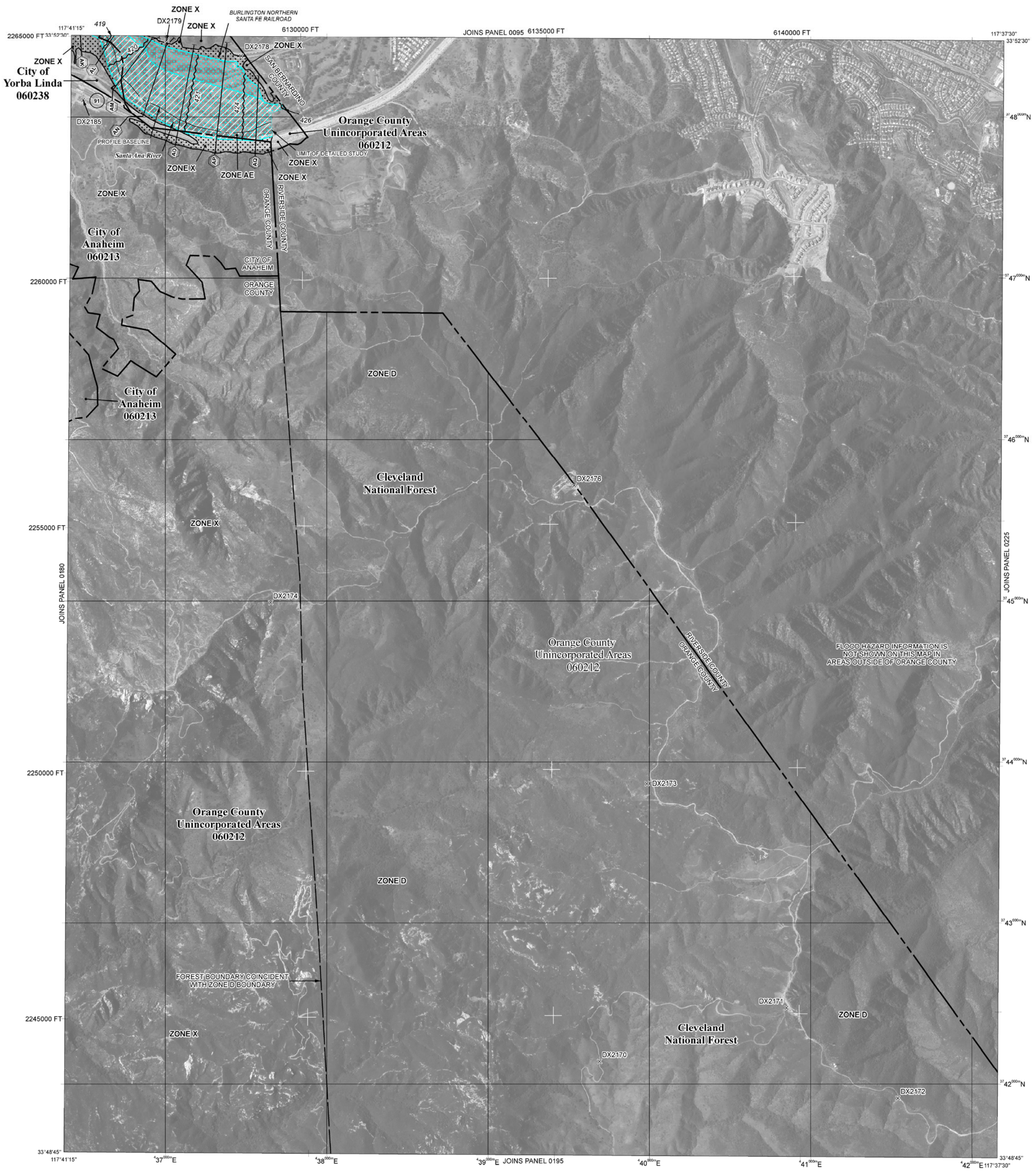
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov.



LEGEND

▨ SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

▨ FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

▨ OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

☐ OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

▨ COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

▨ OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

———	1% annual chance floodplain boundary
———	0.2% annual chance floodplain boundary
— — —	Floodway boundary
– —— —— –	Zone D boundary
••••••••••••••••	CBRS and OPA boundary
▨ ←	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

Ⓐ——Ⓐ	Cross section line
㉓- - - - - -㉓	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone NAD 1983 UTM Zone 11N
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone VI (FIPSZONE 0406), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
September 15, 1989

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 1992 - November 3, 1993 - January 3, 1997 - February 18, 2004 - December 3, 2009 : for description of revisions, see Notice to Users page in the Flood Insurance Study report.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0185J

FIRM
FLOOD INSURANCE RATE MAP

ORANGE COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 185 OF 539

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ANAHEIM, CITY OF	060213	0185	J
ORANGE COUNTY	060212	0185	J
YORBA LINDA, CITY OF	060238	0185	J

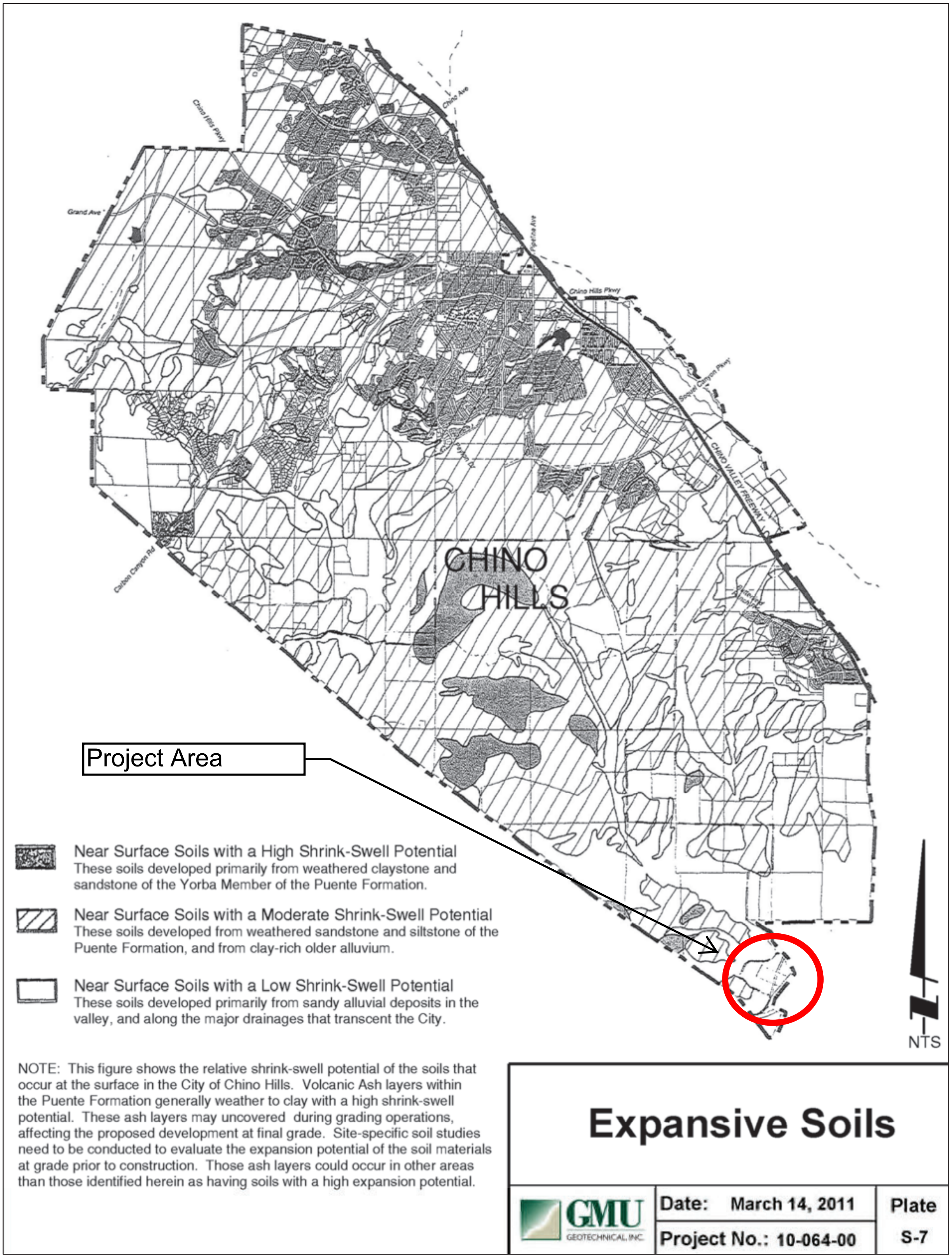
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

**MAP NUMBER
06059C0185J**

**MAP REVISED
DECEMBER 3, 2009**

Federal Emergency Management Agency

APPENDIX I -
EXPANSIVE POTENTIAL MAP



▩ **Near Surface Soils with a High Shrink-Swell Potential**
These soils developed primarily from weathered claystone and sandstone of the Yorba Member of the Puente Formation.

▨ **Near Surface Soils with a Moderate Shrink-Swell Potential**
These soils developed from weathered sandstone and siltstone of the Puente Formation, and from clay-rich older alluvium.

□ **Near Surface Soils with a Low Shrink-Swell Potential**
These soils developed primarily from sandy alluvial deposits in the valley, and along the major drainages that transcent the City.

NOTE: This figure shows the relative shrink-swell potential of the soils that occur at the surface in the City of Chino Hills. Volcanic Ash layers within the Puente Formation generally weather to clay with a high shrink-swell potential. These ash layers may uncovered during grading operations, affecting the proposed development at final grade. Site-specific soil studies need to be conducted to evaluate the expansion potential of the soil materials at grade prior to construction. Those ash layers could occur in other areas than those identified herein as having soils with a high expansion potential.

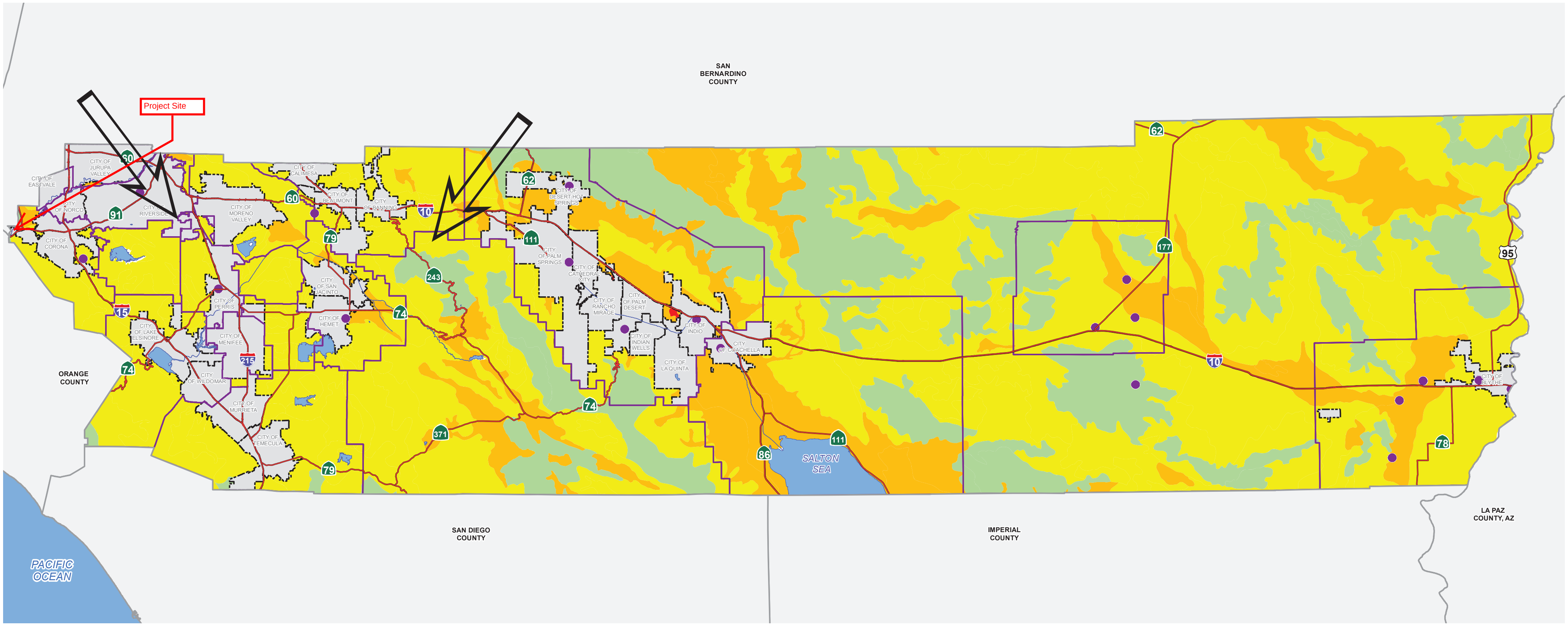
Expansive Soils

GMU GEOTECHNICAL, INC.

Date: March 14, 2011
Project No.: 10-064-00
Plate S-7

Figure 5-6– Expansive Soils

APPENDIX J -
ERODIBILITY MAP



Data Source: Earth Consultants International, RCIP (2004)

Wind Erodibility Rating

- 🟥 Very High
- 🟧 High
- 🟨 Moderate
- 🟩 Low
- ● Weather Station
- ↖ General Wind Direction

- Highways
- Area Plan Boundary
- City Boundary & MJPA
- Waterbodies

Figure S-8

August 6, 2019

0 10 20 Miles

Disclaimer: Maps and data are to be used for reference purposes only. Map features are approximate, and are not necessarily accurate to surveying or engineering standards. The County of Riverside makes no warranty or guarantee as to the content (the source is often third party), accuracy, timeliness, or completeness of any of the data provided, and assumes no legal responsibility for the information contained on this map. Any use of this product with respect to accuracy and precision shall be the sole responsibility of the user.

Disclaimer: For information within City boundary, refer to the City's General Plan, or March JPA General Plan.

WIND EROSION SUSCEPTIBILTY AREAS

\\agency\tlmagis\Projects\Planning\SafetyElement\Wind_Erosion.mxd

APPENDIX K -
CORROSION POTENTIAL

TRANSMITTAL LETTER

DATE: December 8, 2016

ATTENTION: **Luis Vasquez**

TO:
AECOM
2110 East First Plaza, Suite 116
Santa Ana, CA 92705

SUBJECT:
Laboratory Test Data
BNSF Rail Road Bridge Pot Holing
Your #60417373, HDR Lab #16-0899LAB

COMMENTS: Enclosed are the results for the subject project.

James T. Keegan, MD
Laboratory Services Manager

Table 1 - Laboratory Tests on Soil Samples

AECOM
BNSF Rail Road Bridge Pot Holing
Your #60417373, HDR Lab #16-0899LAB
8-Dec-16

Sample ID			East corner of Middler Pier group 3 @ 0-10' SM
Resistivity		**Units**	
as-received		ohm-cm	4,800
minimum		ohm-cm	3,880
pH			7.2
Electrical Conductivity		mS/cm	0.07
Chemical Analyses			
Cations			
calcium	Ca^{2+}	mg/kg	41
magnesium	Mg^{2+}	mg/kg	5.1
sodium	Na^{1+}	mg/kg	37
potassium	K^{1+}	mg/kg	11
Anions			
carbonate	CO_3^{2-}	mg/kg	ND
bicarbonate	HCO_3^{1-}	mg/kg	67
fluoride	F^{1-}	mg/kg	0
chloride	Cl^{1-}	mg/kg	21
sulfate	SO_4^{2-}	mg/kg	55
phosphate	PO_4^{3-}	mg/kg	3.4
Other Tests			
ammonium	NH_4^{1+}	mg/kg	ND
nitrate	NO_3^{1-}	mg/kg	5.1
sulfide	S^{2-}	qual	na
Redox		mV	na

Minimum resistivity per CTM 643, Chlorides per CTM 422, Sulfates per CTM 417

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

TRANSMITTAL LETTER

DATE: April 28, 2017

ATTENTION: **Luis Vasquez**

TO:
AECOM
2110 East First Plaza, Suite 116
Santa Ana, CA 92705

SUBJECT:
Laboratory Test Data
BNSF
HDR Lab #17-0289LAB

COMMENTS: Enclosed are the results for the subject project.

James T. Keegan, MD
Laboratory Services Manager

Table 1 - Laboratory Tests on Soil Samples

AECOM
BNSF
HDR Lab #17-0289LAB
28-Apr-17

Sample ID					
			Pier 2 @ 6 ft	Pier 4 @ 7 ft	Pier 5 @ 8 ft
Resistivity		**Units**			
as-received		ohm-cm	52,000	3,320	2,160
minimum		ohm-cm	13,200	2,840	2,000
pH			6.6	7.1	6.8
Electrical Conductivity		mS/cm	0.04	0.13	0.15
Chemical Analyses					
Cations					
calcium	Ca^{2+}	mg/kg	51	58	57
magnesium	Mg^{2+}	mg/kg	9.2	12	12
sodium	Na^{1+}	mg/kg	18	87	103
potassium	K^{1+}	mg/kg	4.6	13	14
Anions					
carbonate	CO_3^{2-}	mg/kg	ND	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	153	174	198
fluoride	F^{1-}	mg/kg	6.6	22	22
chloride	Cl^{1-}	mg/kg	ND	53	64
sulfate	SO_4^{2-}	mg/kg	11	89	82
phosphate	PO_4^{3-}	mg/kg	ND	ND	1.9
Other Tests					
ammonium	NH_4^{1+}	mg/kg	ND	ND	ND
nitrate	NO_3^{1-}	mg/kg	3.0	ND	ND
sulfide	S^{2-}	qual	na	na	na
Redox		mV	na	na	na

Minimum resistivity per CTM 643, Chlorides per CTM 422, Sulfates per CTM 417

Electrical conductivity in millisiemens/cm and chemical analyses were made on a 1:5 soil-to-water extract.

mg/kg = milligrams per kilogram (parts per million) of dry soil.

Redox = oxidation-reduction potential in millivolts

ND = not detected

na = not analyzed

DISTRIBUTION

One Copy:
Ms. Susan Michalski, PE
Michael Baker International
5 Hutton Centre, Suite 500
Santa Ana, California 92707

QUALITY CONTROL REVIEWER

Saroj Weeraratne, PhD, PE, GE
Associate Engineer

BH/SN:sjd/dr

REPORT VERSION LOG

VERSION NO.	DATE	VERSION DESCRIPTION
1	April 14, 2020	Draft for review
2	April 24, 2020	Final Version for Agency Submittal
3	May 11, 2020	Final Version after Riverside County comments