APPENDIX F

Preliminary Geotechnical Reconnaissance: College Boulevard Widening Between Olive Drive and Old Grove Road

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GEOTECHNICAL
ENVIRONMENTAL
MATERIALS

PRELIMINARY GEOTECHNICAL RECONNAISSANCE

COLLEGE BOULEVARD WIDENING BETWEEN OLIVE AVENUE AND OLD GROVE ROAD (STATION 87+00 TO 136+00) OCEANSIDE, CALIFORNIA

PREPARED FOR

DUDEK & ASSOCIATES
ENCINITAS, CALIFORNIA

JUNE 10, 2016
PROJECT NO. G1787-32-01

GEOCON
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GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS

Project No. G1787-32-01
June 10, 2016

Dudek & Associates
605 Third Street
Encinitas, California 92024

Attention: Mr. Shawn Shamlou

Subject: PRELIMINARY GEOTECHNICAL RECONNAISSANCE
COLLEGE BOULEVARD WIDENING
BETWEEN OLIVE AVENUE AND OLD GROVE ROAD
(STATION 87+00 TO 136+00)
OCEANSIDE, CALIFORNIA

Dear Mr. Shamlou:

In accordance with your authorization of our Proposal (LG-14215 dated July 6, 2015), we have prepared this geotechnical reconnaissance for the College Boulevard widening project in Oceanside, California. The accompanying report describes the site soil and geologic conditions, discusses potential geotechnical constraints and geologic hazards, and provides recommendations for a future geotechnical investigation.

Should you have questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Very truly yours,

GEOCON INCORPORATED

Joseph P. Pagnillo	Trevor E. Myers	David B. Evans
PG 9290	RCE 63773	CEG 1860

JPP:TEM:DBE:dmc

(6/del) Addressee
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PRELIMINARY GEOTECHNICAL RECONNAISSANCE

1. PURPOSE AND SCOPE

This report presents the results of a preliminary geotechnical reconnaissance for the proposed College Boulevard widening project in Oceanside, California (see Vicinity Map, Figure 1). The purpose of this study is to provide preliminary soil and geologic information for the improvement areas, identify known geologic hazards, if any, that may adversely impact the proposed development and assist in planning and development studies.

The scope of our study included a review of readily available published geologic literature and geotechnical reports relative to the existing roadway alignment and the vicinity, and performing a site reconnaissance and preliminary geologic mapping where possible.

2. SITE AND PROJECT DESCRIPTION

The study area of College Boulevard is a four-lane Major Arterial roadway between Olive Avenue and Old Grove Road in Oceanside, California. The roadway was originally developed in the 1970's with surrounding residential and commercial development continuing into the 1980's. The commercial development is concentrated around the Oceanside Boulevard intersection with residential development to the north and south. There is a railroad crossing approximately 500 feet south of Oceanside Boulevard.

We understand the project consists of widening the roadway in select areas by approximately 3 to 12 feet. This will accommodate new turn lanes, bike lanes, etc. Retaining walls are proposed along the majority of the western side of the roadway and portions of the eastern side. The retaining walls are will be constructed at the edge of the right-of-way to accommodate the widening. In addition, the existing median will be reconfigured to add new, or lengthen, existing turn pockets. New surface improvements (sidewalk, curb/gutter, etc.) will also be constructed.

From a geologic standpoint, the subject site is situated on graded cuts and fills, exposing, or overlying the Santiago Formation. Alluvium most-likely underlies compacted fill south of Oceanside Boulevard (approximately Station 91+50 to 95+50). Figure 2 shows the site as depicted on the Regional Geologic Map (Oceanside 30x60 Quadrangle). The topographic relief ranges from approximately 231 feet Mean Sea Level (MSL) near the railroad tracks (Station 92+50) to approximately 407 feet MSL at the intersection of Old Grove Road (Station 136+00).

The approximate overall project limits and locations of proposed improvements are shown on the Geologic Map (Figure 3). The geologic information is a compilation of as-graded reports, published maps, and estimated contacts from our reconnaissance.

3. SOIL AND GEOLOGIC CONDITIONS

Based on our literature review and site reconnaissance, the existing alignment is generally underlain by Santiago Formation, or compacted fill over Santiago Formation. A limited area is likely underlain by alluvium. The thickness of the alluvium is unknown. The geologic units are described in detail below.

3.1 Compacted Fill

Compacted fill soils have been placed in portions of the roadway during the original site grading in the 1970's to achieve the current grades (Reference No. 8). The thickness of the compacted fill is not known since we did not obtain as-graded information for the entire length of roadway. The fill soils most-likely consist of clayey sands, silty sands, silty clays and sandy clays and can exhibit a "low to high" expansion potential.

3.2 Alluvium

Alluvial soils potentially underlie the fill materials in the area of Station 91+50 to 95+50. These stream deposits generally consist of loose silty sands and clayey sands, and soft silty and sandy clays (Reference No. 9). If present, the expansion and compression potential of the alluvial materials should be evaluated during future geotechnical studies. In addition, groundwater may be present within the alluvium. The potential for this condition should also be evaluated during future studies.

3.3 Santiago Formation

The Eocene-age Santiago Formation is exposed at grade along various portions of the roadway. The Santiago Formation generally consists of relatively flat-lying claystone, siltstone, and sandstone units. Weak, waxy claystone and thinly laminated siltstone/claystone and sandstone are typically present within this unit. With the exception of the sandier portions of the Santiago Formation, materials derived from this unit can possess a "medium to high" expansion potential with a moderate to low shear strength. This formation also has the potential to transmit perched water along impervious layers.

The Santiago Formation often exhibits highly cemented zones that may result in excavation difficulty during grading and construction of site improvements (e.g., retaining wall foundations). Moderate to heavy ripping may be necessary in portions of this formation to facilitate excavation. Generation of oversize materials may also occur when excavating in this formation.

4. GROUNDWATER

Based on Reference No. 9, the depth to groundwater is estimated to be approximately 5 feet below ground surface in the area of Station 91+50 to 95+50. Groundwater could have a significant influence on construction depending on the location of any underground utilities if proposed. Stabilization and/or dewatering techniques will likely be necessary for excavations greater than approximately 5 below existing grades in this area. Groundwater elevations may vary seasonally.

5. GEOLOGIC HAZARDS

5.1 Landslides

No evidence of landsliding was noted during the reconnaissance or previous investigations, and no landslides are known to exist along the alignment or at a location that would impact the proposed development.

5.2 Regional Faulting and Seismicity

Based on review of aerial photographs and published geologic maps, the site is not located on any active or potentially active fault trace, as defined by the California Geological Survey (CGS). The site is not located within a State of California Earthquake Fault Zone.

We used the computer program *EZ-FRISK* (Version 7.65) to determine the distance of known faults to the site and to estimate ground accelerations at the site for the maximum anticipated seismic event. According to the computer program *EZ-FRISK* (Version 7.65), ten known active faults are located within a search radius of 50 miles from the site. We used acceleration attenuation relationships developed by Boore-Atkinson (2008) NGA USGS 2008, Campbell-Bozorgnia (2008) NGA USGS 2008, and Chiou-Youngs (2007) NGA USGS 2008 in our analysis. Table 5.2 lists the estimated maximum earthquake magnitude and peak ground acceleration for faults in relationship to the site location calculated for Site Class D as defined by Table 1613.3.2 of the 2013 California Building Code (CBC).

The results of the deterministic analysis indicate that the Newport-Inglewood (off-shore segment) is the dominant sources of potential ground shaking at the site. The Newport-Inglewood Fault is estimated to have the capability to generate a maximum earthquake event of Magnitude 7.5. The estimated maximum peak site acceleration was calculated to be 0.28g. Presented on Table 5.2 are the earthquake events and calculated peak site accelerations for the faults most likely to subject the site to significant ground shaking.

TABLE 5.2
DETERMINISTIC SPECTRA SITE PARAMETERS

Fault Name	Distance from Site (miles)	Maximum Earthquake Magnitude (Mw)	Peak Ground Acceleration		
			Boore-Atkinson 2008 (g)	Campbell-Bozorgnia 2008 (g)	Chiou-Youngs 2008 (g)
Newport-Inglewood	9	7.5	0.28	0.23	0.29
Rose Canyon	10	6.9	0.22	0.19	0.21
Elsinore	18	7.85	0.22	0.15	0.21
Coronado Bank	26	7.4	0.15	0.11	0.12
Palos Verde Connected	26	7.7	0.17	0.12	0.15
San Joaquin Hills	35	7.1	0.10	0.10	0.09
Palos Verdes	37	7.3	0.11	0.08	0.08
Earthquake Valley	40	6.8	0.08	0.06	0.05
San Jacinto	42	7.88	0.12	0.09	0.11
Chino	45	6.8	0.07	0.05	0.04

5.3 Seismicity-Probabilistic Analysis

We performed a probabilistic seismic hazard analysis using the computer program *EZ-FRISK*. The program operates under the assumption that the occurrence rate of earthquakes on each mapped Quaternary fault is proportional to the fault slip rate. The program accounts for earthquake magnitude as a function of rupture length. Site acceleration estimates are made using the earthquake magnitude and distance from the site to the rupture zone. The program also accounts for uncertainty in each of following: (1) earthquake magnitude, (2) rupture length for a given magnitude, (3) location of the rupture zone, (4) maximum possible magnitude of a given earthquake, and (5) acceleration at the site from a given earthquake along each fault. By calculating the expected accelerations from considered earthquake sources, the program calculates the total average annual expected number of occurrences of site acceleration greater than a specified value. We utilized acceleration-attenuation relationships suggested by Boore-Atkinson (2008) NGA USGS 2008, Campbell-Bozorgnia (2008) NGA USGS 2008, and Chiou-Youngs (2007) NGA USGS 2008 in the analysis. Table 5.3 presents the site-specific probabilistic seismic hazard parameters including acceleration-attenuation relationships and the probability of exceedence.

TABLE 5.3
PROBABILISTIC SEISMIC HAZARD PARAMETERS

Probability of Exceedence	Peak Ground Acceleration		
	Boore-Atkinson, 2008 (g)	**Campbell-Bozorgnia, 2008 (g)**	**Chiou-Youngs, 2008 (g)**
2% in a 50 Year Period	0.48	0.41	0.48
5% in a 50 Year Period	0.36	0.31	0.35
10% in a 50 Year Period	0.28	0.24	0.26

While listing peak accelerations is useful for comparison of potential effects of fault activity in a region, other considerations are important in seismic design, including frequency and duration of motion and soil conditions underlying the site. Seismic design of the structures should be evaluated in accordance with the CBC guidelines or those currently adopted by the City of Oceanside.

It is our opinion that the alignment could be subjected to moderate to severe ground shaking in the event of an earthquake along any of the faults listed on Table 5.2 or other faults in the southern California/ northern Baja California region. However, the improvements do not possess any greater seismic risk than that of the surrounding developments.

5.4 Soil Liquefaction and Lateral Spread Potential

Liquefaction typically occurs when a site is located in a zone with seismic activity, on-site soils are cohesionless, groundwater is encountered within 50 feet of the surface, and soil relative densities are less than about 70 percent. If the four previous criteria are met, a seismic event could result in a rapid pore-water pressure increase from the earthquake-generated ground accelerations. Seismically induced settlement is compression that occurs as a result of liquefaction, or as a result of partial re-arrangement in loose dry sands located above the groundwater table.

The County of San Diego Hazard Mitigation Plan (Reference No. 3) identifies zones of high risk for liquefaction in areas throughout the county. The subject roadway alignment does not lie in a high risk zone. However, the alluvial soils within the drainage between stations 91+50 through 95+50 may be prone to liquefaction if the conditions described above are present.

5.5 Tsunamis and Seiches

A tsunami is a series of long-period waves generated in the ocean by a sudden displacement of large volumes of water. Causes of tsunamis include underwater earthquakes, volcanic eruptions, or offshore slope failures. The County of San Diego Hazard Mitigation Plan identifies zones of high risk for tsunami run-up for coastal areas throughout the county. The alignment is not included in the high risk hazard area. Due to the relative elevation of the roadway compared to sea level and distance to the Pacific Ocean, the potential for tsunamis impacting the site is low.

Seiches are caused by the movement of an inland body of water due to the movement from seismic forces. The County of San Diego Hazard Mitigation Plan identifies zones of high risk for dam inundation areas throughout the county. The alignment is not included in the high risk hazard area. The potential of seiches to occur is considered to be very low due to the absence of a nearby inland body of water.

5.6 Slope Stability

No major cut or fill slopes are planned. Based on our observations and experience with similar soil and geologic conditions, the existing slopes should be grossly and surficially stable with respect to deep-seated instability and shallow sloughing conditions.

5.7 Remedial Grading

Remedial grading recommendations will be developed as part of a future geotechnical investigation and will be dependent on the thickness of any loose/soft surficial soils present above competent compacted fill or formational materials. If existing utilities in roadway expansion areas preclude full depth removal of any unsuitable soils, stabilization measures may be considered using geogrid reinforcement (such as Tensar TX130S, Mirafi BXG120, or approved equivalent) and additional aggregate base.

6. FUTURE GEOTECHNICAL INVESTIGATION

A geotechnical investigation will be necessary to evaluate the subsurface conditions along the roadway and to provide recommendations for design and construction of the proposed improvements. The scope of the geotechnical investigation should include performing a subsurface exploration, laboratory testing, and engineering analyses. Infiltration testing may be required to assist in evaluating storm water infiltration feasibility. The report should include recommendations regarding earthwork grading considerations, ground improvement options, and retaining wall and pavement design.

LIST OF REFERENCES

1. Aerial Photographs (AXN 8M-64 and AXN 8M-65, dated April 11, 1953).

2. Risk Engineering (2015), *EZ-FRISK (version 7.65)*.

3. County of San Diego, Office of Emergency Services, *Multi-Jurisdictional Hazard Mitigation Plan, 2010 (Draft)*, www.sandiegocounty.gov/content/sdc/oes/emergencymanagement/oesjlmitplan.html

4. Jennings, C. W., 1994, California Division of Mines and Geology, *Fault Activity Map of California and Adjacent Areas*, California Geologic Data Map Series Map No. 6.

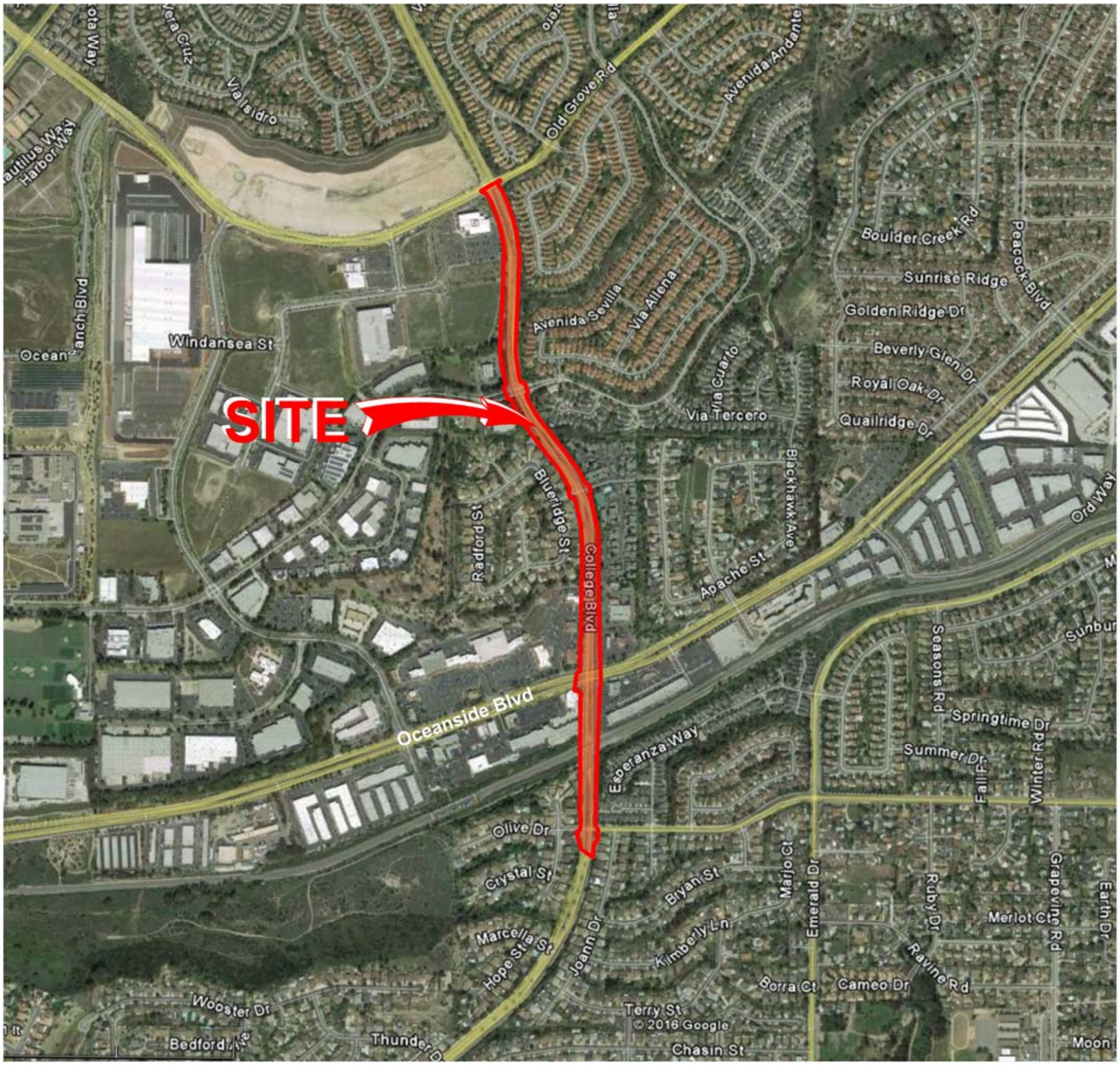
5. Kennedy, M. P. and S. S. Tan, 2005, *Geologic Map of the Oceanside 30'x60' Quadrangle, California*, USGS Regional Map Series Map No. 3, Scale 1:100,000.

6. *Landslide Hazards in the Northern Part of the San Diego Metropolitan Area, San Diego County, California*, California Division of Mines and Geology, Open File Report 95-04 (1995).

7. United States Geological Survey, *7.5 Minute Quadrangle Series* San Luis Rey Quadrangle, 1968, photo revised 1975.

8. *Testing and Observation Services During Grading Operations – Final Report of Work from 6/2 through 10/4/1977, Oceanside Commercial Site, North of Oceanside Blvd, Oceanside, California,* prepared by Geocon Incorporated, dated November 7, 1977 (D-0864-M02).

9. *Soil Investigation, College Boulevard Commercial Site, College Boulevard & Oceanside Boulevard, Oceanside, California,* prepared by Geocon Incorporated, dated February 6, 1980 (D-2096-M01).



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NO SCALE

VICINITY MAP

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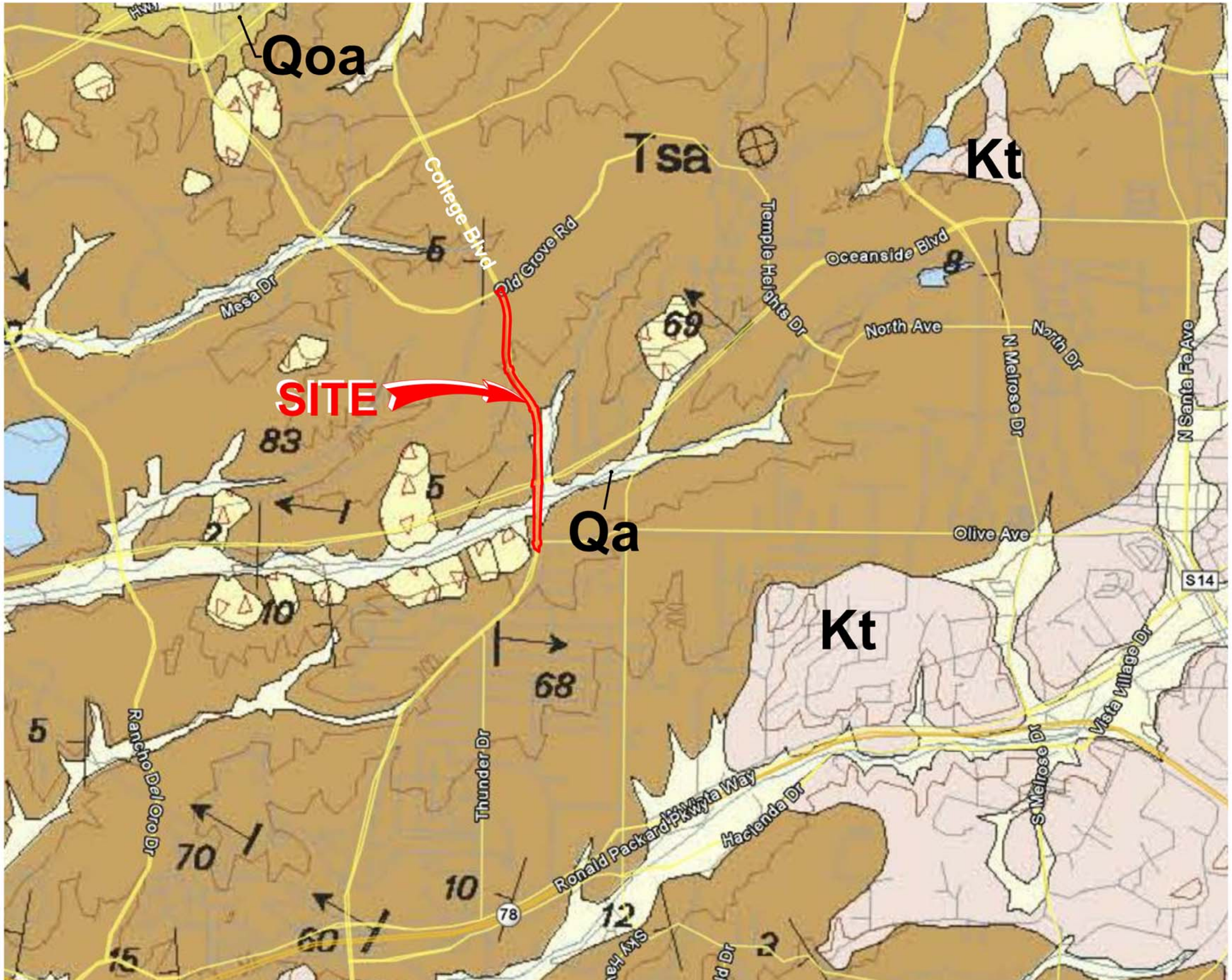
COLLEGE BOULEVARD WIDENING
OCEANSIDE, CALIFORNIA

JP / RA		DSK/GTYPD	DATE 06 - 10 - 2016	PROJECT NO. G1787 - 32 - 01	FIG. 1



0' 2,000' 4,000'
SCALE 1"= 2,000' (On 11x17)

GEOCON LEGEND

Qa ....ALLUVIUM
Qoa ....OLDER ALLUVIUM
Tsa ....SANTIAGO FORMATION
Kt ....TONALITE

SOURCE: Kennedy P. Michael and Tan S. Siang, 2005, *Geologic Map of Oceanside 30'x60' Quadrangle, California*
U.S. Geological Survey, Department of Earth Sciences, University of California, Riverside

REGIONAL GEOLOGIC MAP

COLLEGE BOULEVARD WIDENING
OCEANSIDE, CALIFORNIA

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SCALE 1" = 2,000'	DATE 06 - 10 - 2016	
PROJECT NO. G1787 - 32 - 01		FIGURE 2
SHEET 1 OF 1		

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SEE FIGURE BELOW

SEE FIGURE ABOVE

GEOCON LEGEND

Qcf ....COMPACTED FILL

Qal ....ALLUVIUM (Dotted Where Buried)

Tsa ....SANTIAGO FORMATION

........APPROX./ESTIMATED LOCATION OF GEOLOGIC CONTACT

........APPROX. POTENTIAL AREA OF ***Qcf*** OVERLYING ***Qal***

GEOLOGIC MAP

COLLEGE BOULEVARD WIDENING
OCEANSIDE, CALIFORNIA

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SCALE 1" = 80'	DATE 06 - 10 - 2016	
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SHEET 1 OF 1		

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