Ninyo & Moore
Geotechnical and Environmental Sciences Consultants

GEOLOGIC SITE RECONNAISSANCE
PROPOSED RUGGED SOLAR FARM
BOULEVARD, CALIFORNIA

PREPARED FOR:
AECOM
440 Stevens Avenue, Suite 250
Solana Beach, California 92075

PREPARED BY
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
5710 Ruffin Road
San Diego, California 92123

February 23, 2012
Project No. 107269001

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Mr. Robert Salom
AECOM
440 Stevens Avenue, Suite 250
Solana Beach, California 92075

Subject: Geologic Site Reconnaissance
Proposed Rugged Solar Farm
Boulevard, California

Dear Mr. Salom:

In accordance with your authorization, we have prepared this geologic site reconnaissance report for the proposed Rugged Solar Farm project in eastern San Diego County, California. This report presents our findings, conclusions, and recommendations regarding geologic conditions at the proposed project site.

We appreciate the opportunity to be of service on this project.

Sincerely,
NINYO & MOORE

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TABLE OF CONTENTS

1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geologic reconnaissance study of the proposed Rugged Solar Farm site. The site includes properties located north of Interstate 8 in the vicinity of Ribbonwood Road and McCain Valley Road in eastern San Diego County, California (Figure 1). The purpose of this study was to provide preliminary recommendations regarding the geologic aspects of the proposed project. This report presents our preliminary findings and conclusions pertaining to the geologic conditions at the subject site. Subsurface exploration was not included in the scope of this reconnaissance study.

2. SCOPE OF SERVICES

Ninyo & Moore's scope of services for this project included the following:

- Reviewing background information listed in the References section of this report. The data reviewed included geologic maps, topographic maps, other geologic data, aerial photographs, fault maps, flood zone maps, and online databases.
- Performing a field reconnaissance by a State of California-Certified Engineering Geologist to observe and document surface site conditions.
- Compiling and analyzing the data obtained from our background and field reconnaissance evaluations.
- Preparing this report presenting our preliminary findings, conclusions, and recommendations regarding geologic issues at the site.

3. SITE DESCRIPTION

As noted, the site of the proposed Rugged Solar Farm project is north of Interstate 8 in the vicinity of Ribbonwood Road and McCain Valley Road. Specifically, the project includes properties located east of Ribbonwood Road that are San Diego County Assessor's Parcel Numbers (APNs) 611-060-04, 611-090-02, 611-090-04, 611-091-03, 611-091-07, 611-100-01, 611-100-02, 612-030-01, and 612-030-19 and a property (APN 611-110-01) located adjacent to and east of McCain Valley Road. In total, the project covers approximately 765 acres. Site elevations range from approximately 3,510 feet above mean sea level (MSL) in the easternmost portion of the site, east of McCain Valley Road to approximately 3,680 feet MSL in the northern portion of the site. A shallow drainage, Tule Creek, extends across the majority of the site from near the northwest corner of the site to the southeast.

The majority of the site is currently undeveloped and is covered by sparse to moderate growth of native chaparral, shrubs, low-lying grasses, and scattered trees. Unpaved roads provide access through the project site including roads recently constructed to support construction of the Sunrise Powerlink project. During our site reconnaissance, we observed Sunrise Powerlink transmission towers crossing the project site east of McCain Valley Road. Additionally, the central portion of the project site (APNs 611-100-01 and 611-100-02) is currently being used as a construction storage and staging area. Other improvements include several residential structures and minor agricultural developments in the western portion of the project area.

4. GEOLOGY

Our findings regarding regional and site geology in the area of the proposed solar farm are provided in the following sections.

4.1. Regional Geologic Setting

The project area is situated in the eastern San Diego County section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990; Harden, 1998). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks and Cretaceous igneous rocks of the southern California batholith. The portion of the province in San Diego County that includes the project area generally consists of uplifted granitic mountains and alluvial valleys.

The Peninsular Ranges Province is traversed by a group of sub-parallel faults and fault zones trending approximately northwest. Several of these faults, shown on Figure 2, are considered active faults. The Elsinore, San Jacinto, and San Andreas faults are active fault systems located northeast of the project area, and the Rose Canyon, Coronado Bank, San Diego Trough, and San Clemente faults are active faults located west of the project area. The Vallecitos fault is an active fault system located in Baja California, Mexico, south of the project site. The Coyote Mountain segment of the Elsinore Fault Zone, the nearest active fault system, has been mapped approximately 10.5 miles northeast of the project site. Major tectonic activity associated with these and other faults within this regional tectonic framework consists primarily of right-lateral, strike-slip movement. Further discussion of faulting relative to the site is provided in the Faulting and Seismicity section of this report.

4.2. Site Geology

Based on our review of published geologic maps and our site reconnaissance, earth units at the project site consist of fill, topsoil/colluvium, alluvium, and granitic rock. Granitic bedrock is expected to underlie the site. A map of the regional geology is included as Figure 3. A brief description of these units, as described in the cited literature or as observed at the site, is presented below.

4.2.1. Fill

Fill soils are expected to underlie portions of the site due to road construction, previous land use, and buried utility lines. We anticipate these fills to be relatively shallow and generally composed of locally derived, reworked decomposed granitic rock and alluvial material.

4.2.2. Topsoil/Colluvium

In undisturbed areas of the site, a mantle of topsoil/colluvium was observed. Where observed, these soils generally consisted of dark brown, silty fine to medium sand.

4.2.3. Alluvium

Alluvial soils underlie and grade into the topsoil/colluvial soils in the lower-lying areas of the site. We expect the thickest alluvial soils to exist in the vicinity of Tule Creek. These soils are expected to generally consist of light brown to dark brown, silty fine sand.

4.2.4. Granitic Rock

Granitic bedrock was observed at the surface at several locations and is expected to underlie the site. According to published mapping, this bedrock has been designated the Tonalite of La Posta (Todd, 2004). The rock observed in outcrops across the site observed to generally consist of light brown to light reddish brown, fine- to medium-grained tonalite. Mineral assemblages were observed to consist of quartz and plagioclase, with lesser biotite and hornblende. Leucocratic and pegmatitic dikes with a general northeast-southwest orientation were observed at several locations across the site. These dikes are generally marked by relatively large quartz and plagioclase crystals.

Individual rounded boulders up to 10 feet in diameter were also observed in several areas of the site. Where exposed, the bedrock was observed to be moderately to intensely weathered.

4.3. Groundwater

Indications of surface water were not observed in Tule Creek, which runs through the western-central portion of the project site. Groundwater may exist within the Tule Creek drainage at depths of roughly 15 feet below surface grades. The presence of groundwater should be further evaluated by subsurface evaluation.

Granitic rock lacks porosity or voids and, as a consequence, groundwater in areas of granitic bedrock typically occurs within joints, fractures and local shear zones (e.g. faults). Gouge (areas of clay minerals caused by the grinding of rock masses past each other) in fault zones has been shown to retard the flow of groundwater both vertically and horizontally. The presence of springs may be indicative of groundwater conduction along joints, fractures, or faults. As noted, faults were not observed at the site. In addition, springs or other evidence of surfacing groundwater (e.g. hydrophilic plants) were not observed at the site. In addition, based on a review of the available topographic maps springs are not present in the immediate vicinity of the site.

Per the Geotracker database (Geotracker, 2012), leaking underground storage tanks impacted the aquifer in 1999 at a site approximately 0.5 miles southwest of the site. This site is at an elevation of 3,510 feet above MSL and the low elevation of the project area is approximately 3,515 feet above MSL. Groundwater was observed to be present at a depth of approximately 17 feet below the existing ground surface at this location (AMEC, 2006).

5. GEOLOGIC HAZARDS

In general, hazards associated with seismic activity include ground surface rupture, strong ground motion, and liquefaction. These considerations and other geologic hazards such as landsliding are discussed in the following sections.

5.1. Faulting and Seismicity

Like much of southern California, the subject site is considered to be in a seismically active area. Based on our review of readily available published geological maps and literature, the subject site is not underlain by known active or potentially active faults (i.e., faults that exhibit evidence of ground displacement in the last 11,000 years and 2,000,000 years, respectively). The subject site is not located within a State of California Earthquake Fault Zone (formerly known as an Alquist-Priolo Special Studies Zone) (Hart and Bryant, 2007). The Elsinore (Coyote Mountain) fault zone is located approximately 10.5 miles northeast of the site.

Table 1 lists selected principal known active faults that may affect the subject site, the maximum moment magnitude (M_{max}) and the fault types as published for the California Geological Survey (CGS) by Cao et al. (2003). The approximate fault to site distance was calculated by the computer program FRISKSP (Blake, 2001) or measured on available geologic maps.

Table 1 – Principal Active Faults

Fault	Distance miles (kilometers) [1,2]	Moment Magnitude/ Fault Type [1]
Elsinore (Coyote Mountain)	10.5 (17)	6.8/A
Elsinore (Julian Segment)	20 (32)	7.1/A
Laguna Salada	23 (38)	7.0/A
Earthquake Valley	28 (45)	6.5/B
San Jacinto (Borrego Segment)	29 (46)	6.6/A
Superstition Mountain	30 (48)	6.6/A
Superstition Hills	34 (55)	6.6/A
Elmore Ranch	34 (55)	6.6/B
San Jacinto (Coyote Creek Segment)	36 (58)	6.8/A
San Jacinto (Anza Segment)	41 (66)	7.2/A
Imperial	44 (72)	7.0/A
Brawley Seismic Zone	49 (79)	6.4/B
Rose Canyon	51 (82)	7.2/B
Coronado Bank	56 (91)	7.6/B
San Andreas	56 (91)	7.2/A

Notes:
[1] Blake (2001)
[2] Cao, et al. (2003)

In general, hazards associated with seismic activity include strong ground motion, ground surface rupture, liquefaction, seismically induced settlement, and tsunamis. These hazards are discussed in the following sections.

5.1.1. Strong Ground Motion

Based on the peak horizontal ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for PGA_{MCE} is approximately 2,475 years. In evaluating the seismic hazards associated with the project site, we have used a Site Class D for this preliminary evaluation. Seismic hazards and classifications should be further evaluated through a full geotechnical evaluation including subsurface and laboratory evaluation. If the results of the geotechnical evaluation indicate a different Site Class, the following estimations will be revised. The site modified PGA_{MCE} is an estimated 0.49g using the United States Geological Survey (USGS) (USGS, 2011) ground motion calculator (web-based). The design PGA was 0.32g using the USGS ground motion calculator. These estimates of ground motion do not include near-source factors that may be applicable to the design of structures on site.

5.1.2. Surface Ground Rupture

Based on our review of the referenced literature and our site reconnaissance, active faults are not known to cross the project site. Therefore, the probability of damage from surface fault rupture is considered to be low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

5.1.3. Liquefaction and Seismically Induced Settlement

Liquefaction of cohesionless soils can be caused by strong vibratory motion due to earthquakes. Research and historical data indicate that loose granular soils and non-plastic silts that are saturated by a relatively shallow groundwater table are susceptible to liquefaction. Our preliminary evaluation indicates that the majority of the project site is underlain by dense granitic materials and therefore not susceptible to liquefaction. However, the potential for liquefaction or seismically induced settlement may exist in the areas of the site along Tule Creek. The potential for liquefaction should be further evaluated during a full geotechnical evaluation including subsurface borings and laboratory evaluation.

5.1.4. Landsliding

Based on our review of referenced geologic and topographic maps, literature, and stereoscopic aerial photographs, landslides, or indications of deep-seated landsliding were not noted underlying the project site. The potential for significant large-scale slope instability at the site is not a design consideration. Exposures of granitic boulders observed during our limited site reconnaissance appeared to be in relatively stable conditions and in our opinion pose a low threat of rockfall. Slope stability and rock fall potential should be further evaluated as part of a full geotechnical evaluation.

5.1.5. Flood Hazards

Based on review of a Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) (FEMA, 1997), the site is mapped as lying outside of the 500-year floodplain. Based on this review, the potential for flooding of the site is considered low. In addition, due to the elevation, topography, and the inland location of the property, the site is not considered susceptible to tsunamis or seiches.

6. CONCLUSIONS

The following conclusions were derived from our geologic reconnaissance and review of background information.

- Based on our review of published geologic maps, the project area is expected to be underlain by fill, topsoil/colluvium, alluvium, and granitic rock.
- No active faults have been mapped or were observed within the study area.
- Groundwater beneath the site is expected in the vicinity of Tule Creek at depths of roughly 15 feet below surface grades and may be present within fractures or joint systems within the granitic bedrock.
- Based on the anticipated shallow groundwater and alluvial materials in the vicinity of Tule Creek, the liquefaction potential should be evaluated prior to construction of the solar farm project.

7. RECOMMENDATIONS

We recommend that a comprehensive geologic and geotechnical evaluation, including subsurface and laboratory exploration, be conducted prior to design and construction of the solar farm project. The purpose of the subsurface evaluation would be to evaluate the subsurface conditions and to provide information pertaining to the geologic and geotechnical conditions, including liquefaction potential, at the project site.

8. LIMITATIONS

The geotechnical analyses presented in this report has been conducted in accordance with current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No warranty, implied or expressed, is made regarding the conclusions, recommendations, and professional opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered. Our preliminary conclusions and recommendations are based on an analysis of the observed surface conditions and the referenced background information. Subsurface evaluations were not performed as part of this study.

9. REFERENCES

AECOM, 2012, Site Plan, Rugged Solar LLC, Sheet S-101: dated January 4.

AMEC, 2006, Monitoring Well Installation and Soil Sampling Report for MW-4, McCain Valley Conservation Camp, 2550 McCain Valley Road, Boulevard, CA 91905, Case Number H20051: dated January 10.

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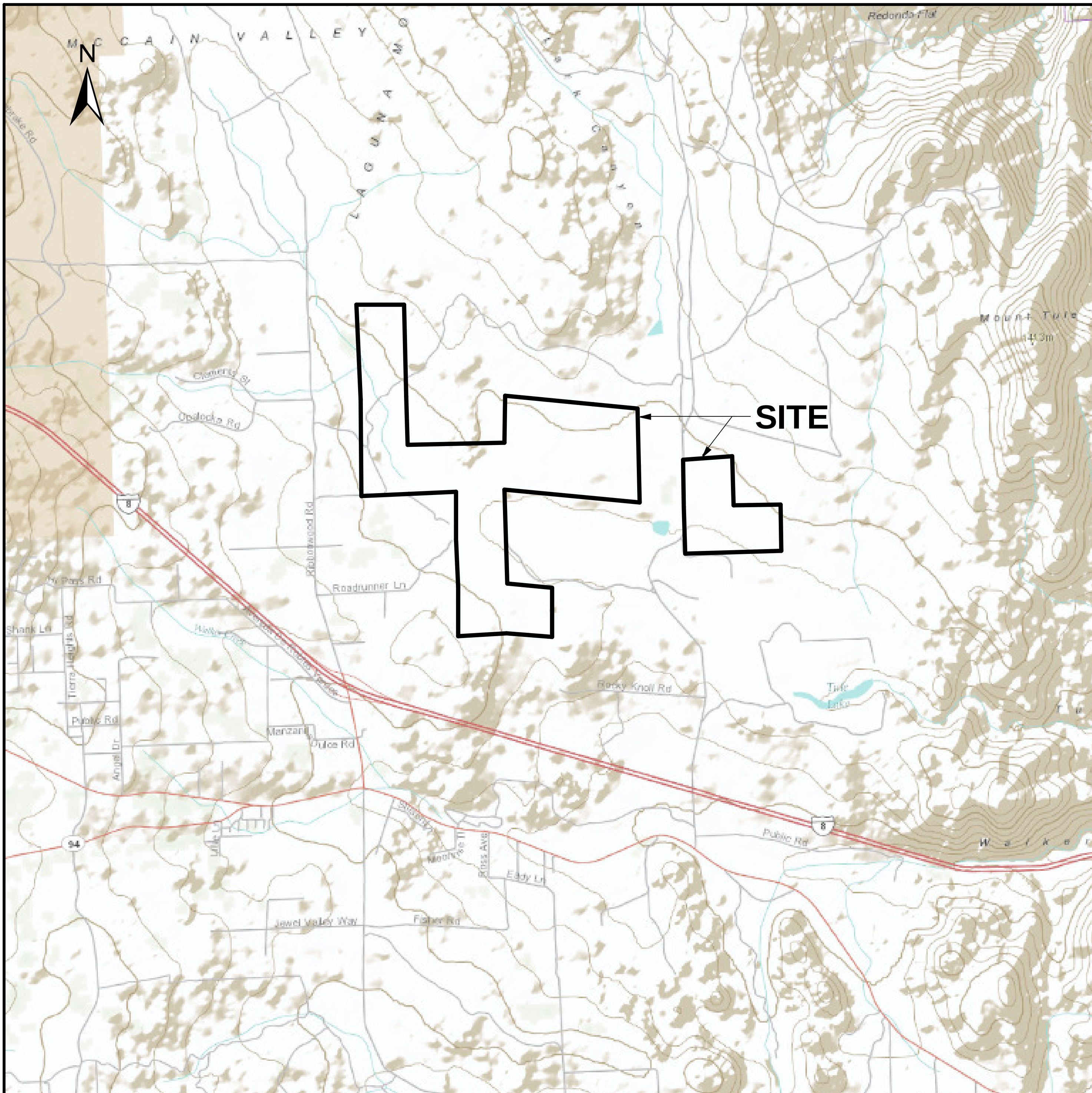
United States Federal Emergency Management Agency (FEMA), 2002, Flood Insurance Rate Map (FIRM), Map Number 06073C2075F: effective date July 2.

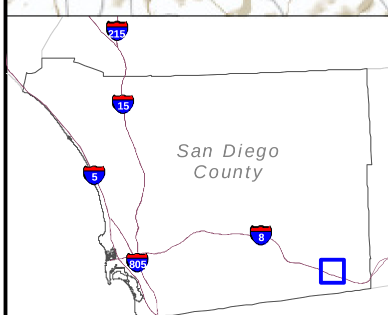
United States Geological Survey, 1959 (Photorevised 1975), Live Oak Springs Quadrangle, California, 7.5-Minute Series: Scale 1:24,000.

United States Geological Survey, 2011, Earthquake Ground Motion Parameters, Version 5.1.0, World Wide Web, http://earthquake.usgs.gov/research/hazmaps/design/; accessed 2012.

AERIAL PHOTOGRAPHS				
Source	**Date**	**Flight**	**Numbers**	**Scale**
USDA	March 30, 1953	AXN-2M	69 and 70	1:24,000
County of San Diego	1928	75C	4 and 5	1:18,000
County of San Diego	1928	75D	4, 5, and 6	1:18,000



SOURCE: ESRI World Topo - SOURCE: USGS, FAO, NPS, EPA, ESRI, DeLorme, TANA, other suppliers, 2011



MAP INDEX

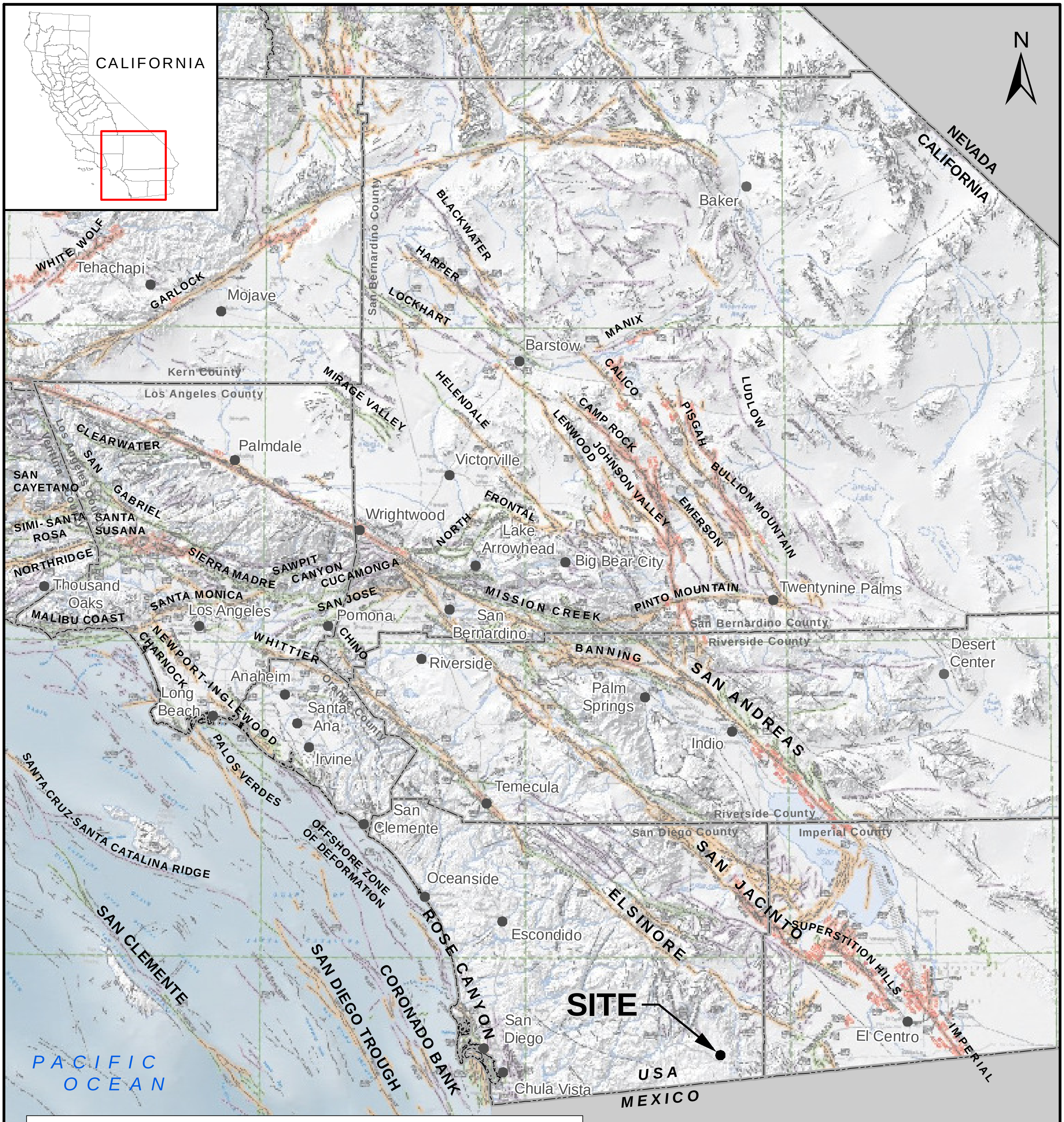
SCALE IN FEET

0 2,000 4,000 8,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore		SITE LOCATION	FIGURE
PROJECT NO.	DATE	PROPOSED RUGGED SOLAR FARM BOULEVARD, CALIFORNIA	1
107269001	2/12		

J:\Projects\100000_SD\107250_107299\107269001_Rugged_Solar\GIS\fig1_107269001_sl.mxd 2/27/2012 3:30:26 PM JDL



LEGEND

CALIFORNIA FAULT ACTIVITY

- HISTORICALLY ACTIVE
- HOLOCENE ACTIVE
- LATE QUATERNARY (POTENTIALLY ACTIVE)
- QUATERNARY (POTENTIALLY ACTIVE)
- STATE/COUNTY BOUNDARY

SOURCE: Fault Activity Map of California, 2010, Jennings, C.W., and Bryant, W.A., California Geological Survey.

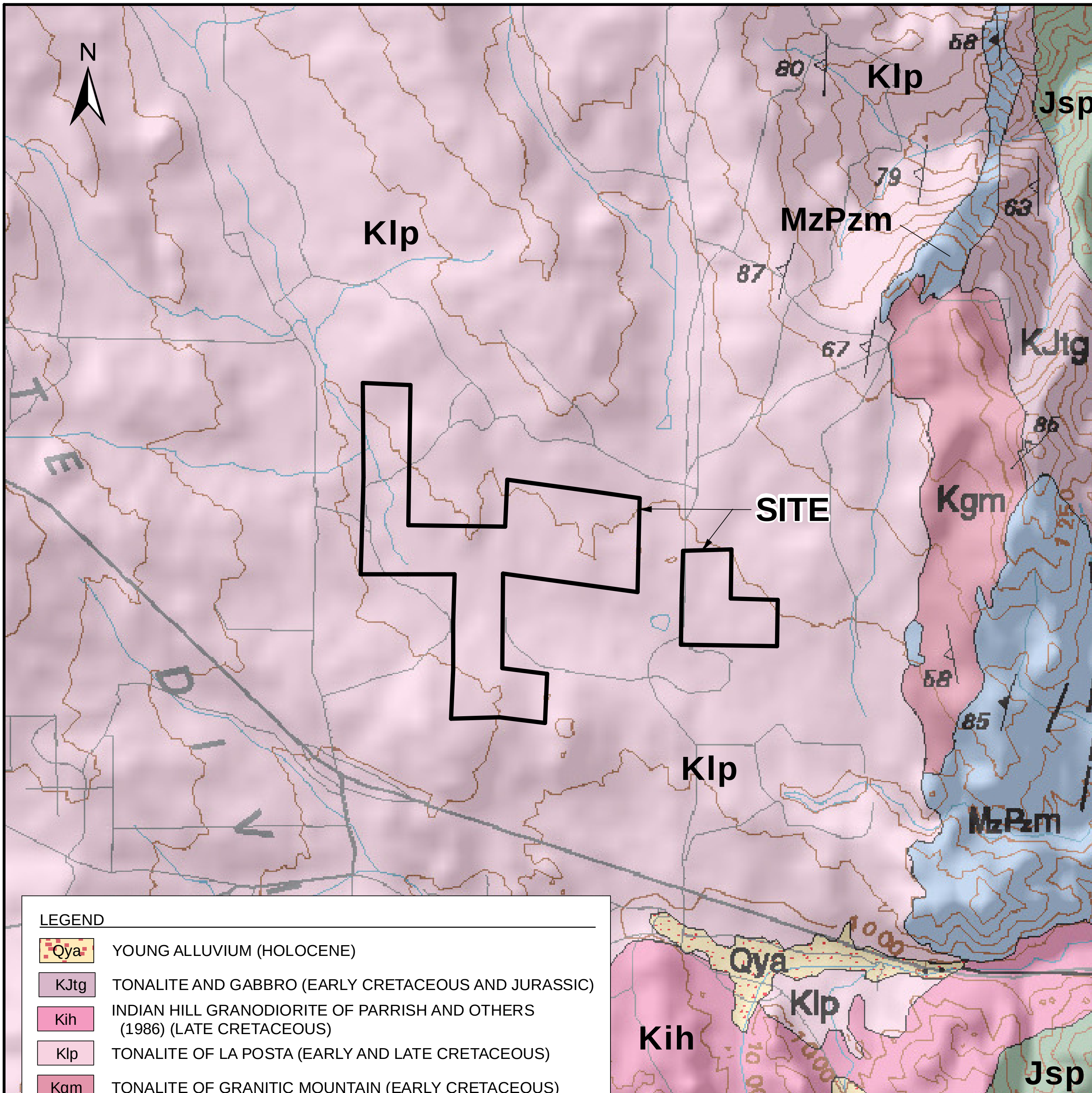
SCALE IN MILES

0 30 60

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore		FAULT LOCATIONS	FIGURE
PROJECT NO.	DATE	PROPOSED RUGGED SOLAR FARM BOULEVARD, CALIFORNIA	2
107269001	2/12		

J:\Projects\100000_SD\107250_107299\107269001_Rugged_Solar\GIS\fig2_107269001_fl.mxd 2/15/2012 4:58:35 PM JDL



LEGEND

Qya	YOUNG ALLUVIUM (HOLOCENE)
KJtg	TONALITE AND GABBRO (EARLY CRETACEOUS AND JURASSIC)
Kih	INDIAN HILL GRANODIORITE OF PARRISH AND OTHERS (1986) (LATE CRETACEOUS)
Klp	TONALITE OF LA POSTA (EARLY AND LATE CRETACEOUS)
Kgm	TONALITE OF GRANITIC MOUNTAIN (EARLY CRETACEOUS)
Jsp	MIGMATITIC SCHIST AND GNEISS OF STEPHENSON PEAK (LATE AND MIDDLE JURASSIC)
MzPzm	ROCKS OF JACUMBA MOUNTAINS (MESOZOIC AND PALEOZOIC?)
80	STRIKE AND DIP OF FOLIATION, PRIMARY IGNEOUS INCLINED
85	STRIKE AND DIP OF FOLIATION, METAMORPHIC INCLINED
	FAULT - SOLID WHERE ACCURATELY LOCATED, DASHED WHERE APPROXIMATELY LOCATED

SOURCE: TODD, V. R., 2004, GEOLOGIC MAP OF THE EL CAJON 30' X 60' QUADRANGLE, SOUTHERN CALIFORNIA

SCALE IN FEET

0 2,000 4,000 8,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

Ninyo & Moore

PROJECT NO.	DATE	REGIONAL GEOLOGY	FIGURE
107269001	2/12	PROPOSED RUGGED SOLAR FARM BOULEVARD, CALIFORNIA	3