

Appendix 3.7-1
**Feasibility-Level Geotechnical Study for the Las Camas
Solar Project**

FEASIBILITY-LEVEL GEOTECHNICAL STUDY FOR THE LAS CAMAS SOLAR PROJECT, MERCED COUNTY, CALIFORNIA

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Acronyms and Abbreviations

The following definitions are of acronyms and abbreviations used in this technical report:

bgs	below the ground surface
BMPs	best management practices
CalGEM	Department of Conservation's Geologic Energy Management Division
CPUC	California Public Utilities Commission
EFZs	Earthquake Fault Zones
FEMA	Federal Emergency Management Agency
G.O.	General Order
gen-tie	generation-tie
I	Interstate
NEHRP	National Earthquake Hazards Reduction Program
PG&E substation improvements	proposed improvements to PG&E Los Banos Substation
proposed project	Las Camas Solar Project (includes solar project and PG&E substation improvements)
PV	photovoltaic
quad	quadrangle
solar project	proposed Las Camas solar facility
solar project site	1,741-acre site of proposed Las Camas solar facility
SP 42	Special Publication 42
SR	State Route
SWPPP	Stormwater Pollution Prevention Plan
USGS	U.S. Geological Survey

1.1 Introduction and Overview

EDP Renewables North America, LLC, engaged ICF to provide technical assistance related to geologic and soil conditions by conducting a feasibility-level geotechnical study for the Las Camas Solar Project (proposed project). The proposed project consists of the proposed Las Camas solar facility (solar project), located on undeveloped, privately owned land (solar project site), and improvements to Pacific Gas and Electric Company's (PG&E) Los Banos substation (PG&E substation improvements), located west of the solar project site. The solar project site and PG&E substation are west of Los Banos in Merced County, California. This evaluation was conducted in support of the environmental analysis documentation for the project.

This feasibility-level geotechnical study is organized into the following seven chapters:

1. Introduction
2. Existing Geologic Conditions
3. Regulatory Setting
4. Faults and Seismicity
5. Other Geologic Hazards
6. Conclusions and Recommendations
7. References

1.2 Purpose

This feasibility-level geotechnical study for the Las Camas Solar Project has been prepared to identify potential geologic hazards and soil conditions, including fault rupture, seismic shaking, liquefaction, landslides, erosion, and unstable and expansive soils, that could result in the proposed project having an adverse effect on the environment or those same geologic hazards and soil conditions being exacerbated by the proposed project. The desktop study is based on an initial evaluation of readily available information. It is intended to inform the environmental analysis for the project. A design-level geotechnical report should be prepared by a licensed engineer in accordance with generally accepted geotechnical engineering practices.

1.3 Scope of Services

The scope of services for this feasibility-level geotechnical study technical report consisted of a review of available topographic and geologic maps, published geotechnical literature, geologic and seismic data, soil data, and groundwater data; compilation and analysis of existing geotechnical data

pertaining to the site; evaluation of the general geologic conditions and seismic hazards affecting the area and their potential to affect the proposed project; and preparation of the technical report, including documentation of the scope of work performed, findings, and recommendations. The scope of work did not include field sampling or testing.

The area evaluated in this feasibility-level geotechnical study includes the approximately 1,741-acre solar project site and immediately adjacent areas where the generation-tie line and PG&E substation improvements would be constructed. It should be noted that the project includes two off-site components that will be evaluated in the environmental analysis for the proposed project; however, these are outside the scope of this study:

- **Off-Site Mitigation Site.** The project would establish a 1,498-acre (minimum) off-site mitigation site for San Joaquin kit fox. The mitigation site, which would be near the eastern and southern edges of Los Banos Reservoir, would be placed into a conservation easement in perpetuity, with the land managed to provide habitat for San Joaquin kit fox. The conservation easement on the mitigation site would require the continuation of current land management practices, including livestock grazing. Establishment and management of the mitigation site would not change the use or geological conditions of the mitigation site. Impacts on geology and soils at the off-site mitigation site will be evaluated in the environmental analysis for the proposed project. They are not addressed further in this feasibility-level geotechnical study.
- **Off-Site Residential Redesignation Area.** The proposed project includes an amendment to the Merced County General Plan to redesignate roughly 202.8 acres immediately south of the solar project site from single-family residential to high-density/medium-density residential. The proposed redesignation would preserve the supply of medium-density and/or high-density units in the county during the life of the project. The project does not propose any development within the off-site residential redesignation area. Impacts on geology and soils at the proposed residential redesignation area will be evaluated in the environmental analysis for the proposed project. Given the proximity to the solar project site, geologic and soil conditions at the off-site residential redesignation area are expected to be similar to conditions at the solar project site. They are not addressed further in this feasibility-level geotechnical study.

2020 Preliminary Geotechnical Report

Portions of this technical report were supported by the *Preliminary Geotechnical Report, Las Camas Solar Project, Merced County, California*, dated May 15, 2020, and prepared by RRC Power & Energy, LLC (RRC Power & Energy, LLC 2020). The 2020 geotechnical investigation was conducted within the proposed 1,741-acre solar project site. The purpose of the 2020 geotechnical investigation was to 1) explore subsurface soil and groundwater conditions, 2) conduct field and laboratory testing to characterize the engineering properties of subsurface materials at select locations, and 3) provide preliminary geotechnical recommendations. As part of the geotechnical investigation, four geotechnical borings were drilled to a depth of 20.5 feet below the existing site grade, along with four test pits, which were excavated to 10 feet below the site grade. All fieldwork was conducted within the solar project site. Given the proximity of the areas where the off-site generation-tie line and PG&E substation improvements would be constructed (i.e., within a 0.25-mile radius of the solar project site boundary), on-site conditions in those areas are expected to be substantially similar to those on the solar project site, as described in the geotechnical investigation.

1.4 Project Location and Site Description

The Las Camas Solar Project would be sited on approximately 1,741 acres of undeveloped, privately owned land approximately 3 miles southeast of the community of Santa Nella, 6 miles west of Los Banos, and approximately 30 miles southwest of Merced. The solar project site is at the southwest corner of the intersection of State Route (SR) 33/SR 152 and Interstate (I) 5 and can be accessed via Billy Wright Road off of SR 33/SR 152 (Figure 1-1). The solar project site includes land designated as Urban Communities (approximately 1,180 acres) and Agricultural (approximately 561 acres) under the Merced County General Plan. The Urban Communities designation is associated with the Villages of Laguna San Luis Community Plan and includes a mix of different land uses, including Low-Density Residential, Medium-Density Residential, Business Park, and Open Space. The solar project site includes assessor's parcel numbers 078-160-012, 078-160-013, 078-160-047, 078-160-056, 078-160-060, 078-172-001, 078-190-004, and 078-190-005, except a portion of 078-172-001. The solar project site is undeveloped, consisting predominantly of non-native annual grassland. Portions of the solar project site are used for grazing and dry-land farming.

PG&E's Los Banos substation is located approximately 0.2 mile west of the solar project site. The substation equipment is located within a footprint of approximately 47 acres within the substation fence.¹

The surrounding area is rural in character. There is a residential subdivision, recreational vehicle park, and commercial area at the junction of SR 152 and SR 33 north of the solar project site. The Billy Wright Landfill is adjacent to the solar project site, south of Billy Wright Road. The San Luis Reservoir State Recreation Area is located further west. The lands immediately east of I-5 support orchards, grazing, and dry farming, as well as the aqueducts of the Central Valley Project. Farther east, irrigated agriculture is the primary land use. The community of Santa Nella, to the north, and the City of Los Banos, to the east, are several miles from the proposed solar project site.

The proposed project consists of a solar photovoltaic (PV) facility that would generate electricity from ground-mounted, single-axis tracking arrays and includes a battery storage facility that would intermittently store electricity by charging and discharging lithium-ion batteries. The solar project would have a solar PV capacity of approximately 200 megawatts, alternating current, and a battery storage capacity of approximately 100 megawatts, direct current or alternating current (both options are under consideration). The solar project would also include a 230-kilovolt generation-tie (gen-tie) transmission line originating from a new substation within the solar project site and terminating at PG&E's Los Banos Substation. The gen-tie line would be approximately 0.4 mile long, based on the proposed location of the project substation along the western boundary of the solar project site. The proposed project also includes transmission system improvements around PG&E's Los Banos Substation (e.g., connecting the substation to the solar project's gen-tie line, installing a new bay with new circuit breakers, and constructing a new ground grid).

¹ As measured on Google Earth.

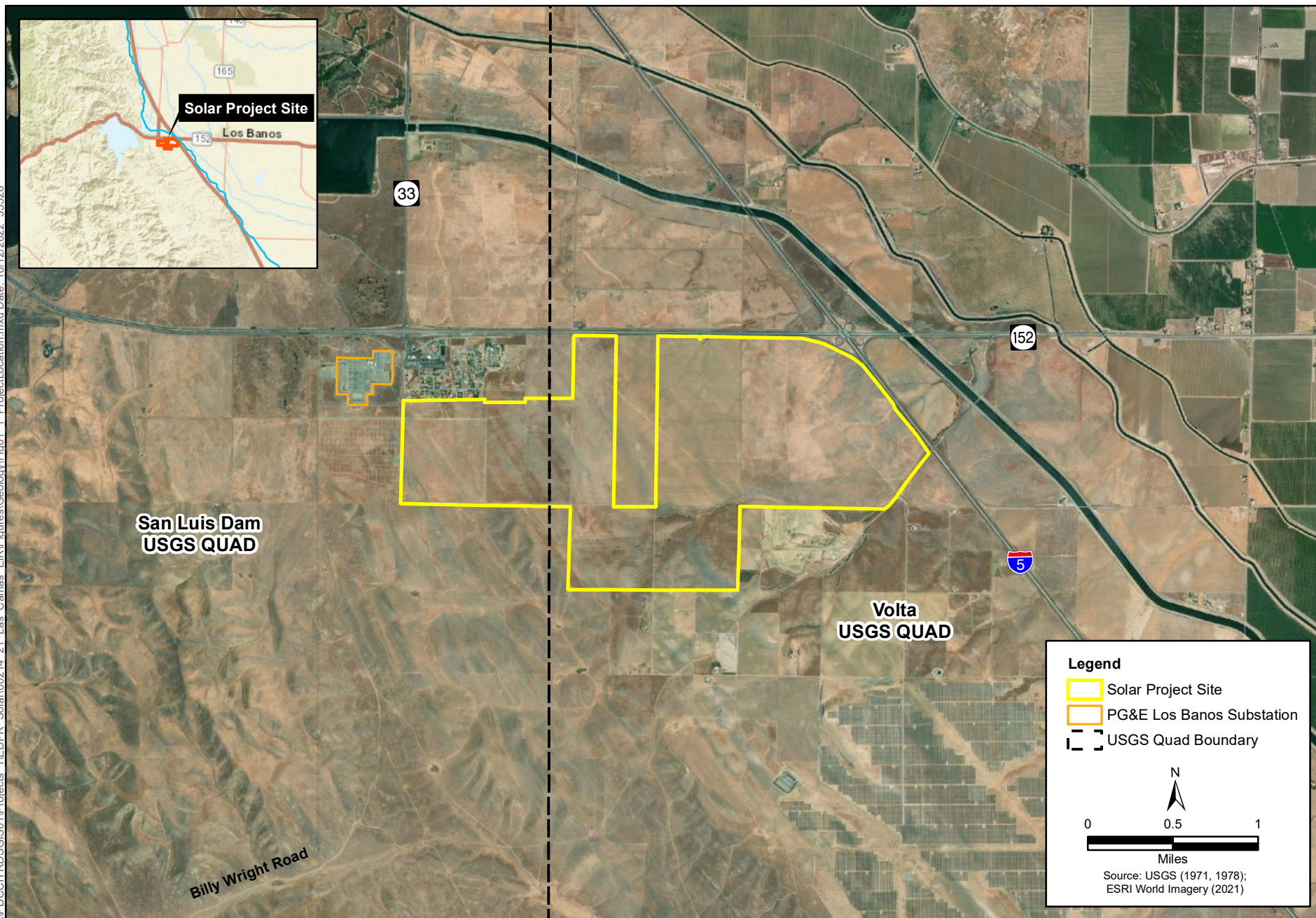


**Figure 1-1
Project Location**

Chapter 2

Existing Geologic Conditions

The following chapter includes a description of on-site geologic conditions, including site topography, the floodplain, soils, and project area groundwater depth.

2.1 Regional Geology

The solar project site and PG&E substation lie within California's Great Valley Geomorphic Province.² The Great Valley is an alluvial plain, about 50 miles wide and 400 miles long, in the central part of California. Its northern part is the Sacramento Valley, which is drained by the Sacramento River, and its southern part is the San Joaquin Valley, which is drained by the San Joaquin River. The Great Valley is a trough in which sediments have been deposited almost continuously since the Jurassic (about 160 million years ago). Great oil fields have been found in the southernmost San Joaquin Valley and along anticlinal uplifts on its southwestern margin. In the Sacramento Valley, the Sutter Buttes, the remnants of an isolated Pliocene volcano, rise above the valley floor (California Geological Survey 2002).

From the time the valley first began to form, sediments derived from the erosion of igneous and metamorphic rocks and consolidated marine sediments in the surrounding mountains have been transported into the valley by streams. These continental sediments are thicker than 10,000 feet at the southern end of the valley and have an average thickness of about 2,400 feet. The continental sediments consist mostly of sand and gravel interbedded and mixed with clay and silt. Depending upon location, deposits of fine-grained materials (mostly clay and silt) make up as much as 50 percent of the thickness of the valley fill sediments (Mintier Harnish 2013).

The geologic formations found within Merced County are composed of the Basement Complex, Ione Formation, Valley Springs Formation, Mehrten Formation, Tulare Formation, and recent alluvium. The Basement Complex is composed of crystalline igneous and metamorphic rocks and lies beneath the sedimentary units. The Ione Formation, reflecting its heritage as delta alluvial deposits, is composed of claystone and sandstones, with a small percentage of conglomerates. The Valley Springs Formation is alluvium composed of sandstones, siltstones, and claystones. The Mehrten Formation is alluvium composed of conglomerates, sandstones, siltstones, and claystones. The lacustrine Tulare Formation is composed of claystone, sandstone. Within the Tulare Formation is the Corcoran Clay Member, a prominent aquitard found throughout the Merced region. Quaternary river and floodplain deposits, consisting of clays, silt, sands, and gravel, overly the formations as soil deposits. The thin interbedded and clay-rich nature of these deposits dominates the geology.

² California's geomorphic provinces are naturally defined geologic regions that display a distinct landscape or landform. Earth scientists recognize 11 provinces in California. Each region displays unique defining features, based on geology, faults, topographic relief, and climate.

2.2 Local Geology

As shown in Figure 1-1, the largest portion of the solar project site is within the U.S. Geological Survey (USGS) Volta 7.5-minute topographic quadrangle (quad). The western portion of the solar project site and the PG&E substation are within the USGS San Luis Dam 7.5-minute topographic quad. According to the USGS map of the Volta and San Luis Dam quadrangles (USGS 2021a), the solar project site is situated in an area with the following geologic formations (Figure 2-1):

- Older Surficial Sediments – Older alluvial gravel and sand (Qoa)
- Older Surficial Sediments – Alluvial gravel, sand, and clay of valley areas (Qa)
- Tulare Formation – Mostly alluvial claystone (gray, massive, and soft), including minor sand and pebble conglomerate (QTt)
- Tulare Formation – Marl (white and soft but coherent, thickly bedded, freshwater evaporite), locally, upper part of Tulare Formation (QTm)
- Moreno Shale – Clay shale or claystone (gray, vaguely bedded, micaceous, argillaceous, and crumbly) (Km)
- Panoche Formation – Clay shale or claystone (dark gray, bedded, micaceous, and argillaceous), including thin layers of sandstone locally (Kp)
- Panoche Formation – Sandstone (light gray to light brown, bedded, hard, fine to medium grained, and arkosic; some members contain large, hard, dark-brown concretions), including minor amounts of interbedded clay shale, similar to Kp (Kps)

The geologic formations at the PG&E substation consist of Older Surficial Sediments (Qoa) and Panoche Formation – Sandstone (Kps).

2.3 Topography and Floodplain

Topography within the solar project site is mostly flat or gently rolling, with an average slope of 4.9 percent. Steeper slopes are clustered near the southwest corner of the site and along a riverine feature. Elevation on the solar project site ranges from approximately 220 feet above sea level at the lowest point to 558 feet at the highest point. Topography at the PG&E substation is generally flat at an elevation of approximately 310 feet above sea level. Please refer to Figure 2-2.

According to the Federal Emergency Management Agency's (FEMA's) National Flood Hazard Layer Viewer (FEMA 2020), the solar project site and the PG&E substation are located within Zone D, an area of undetermined flood hazard (Figure 2-3).

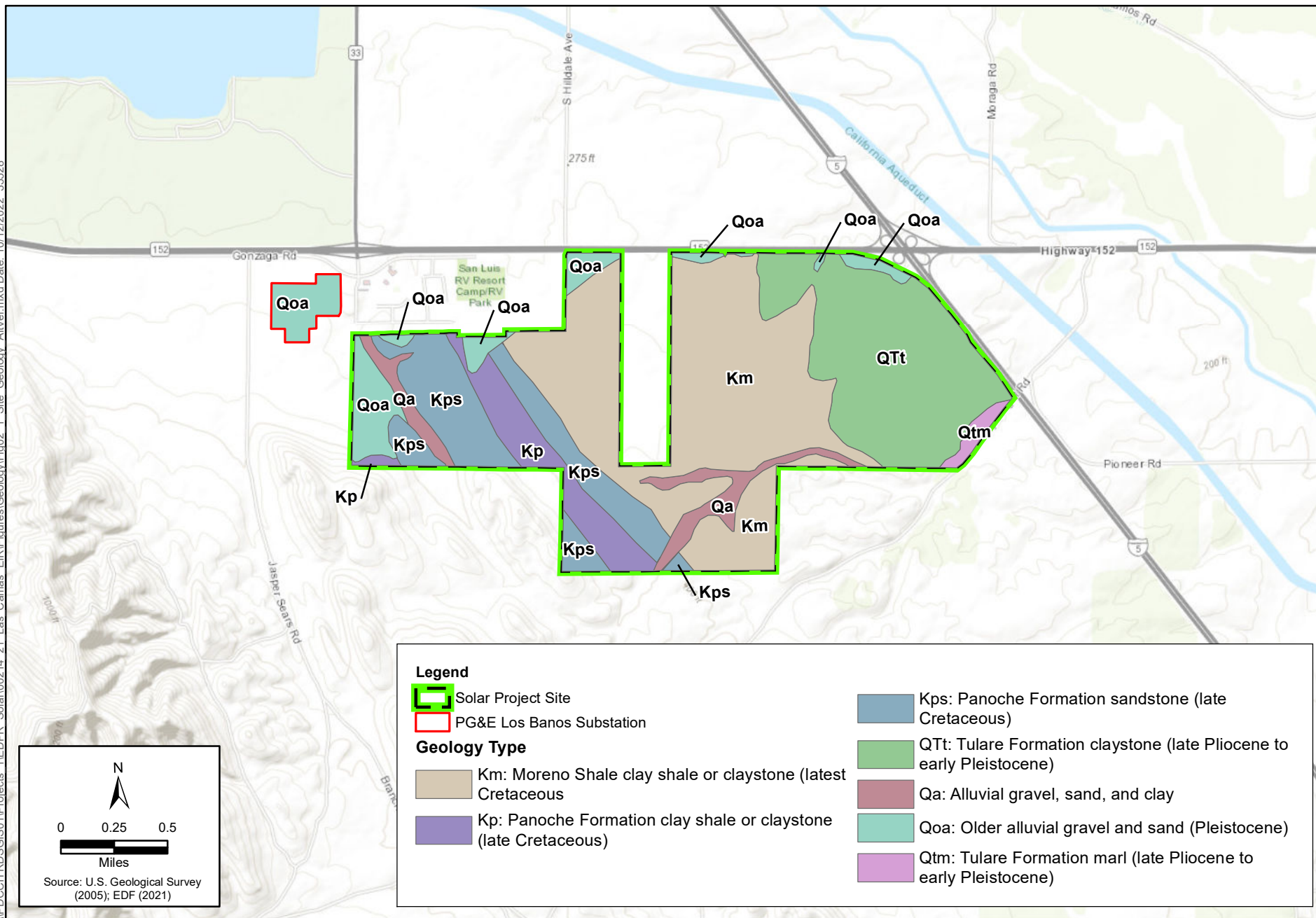


**Figure 2-1
Site Geology**

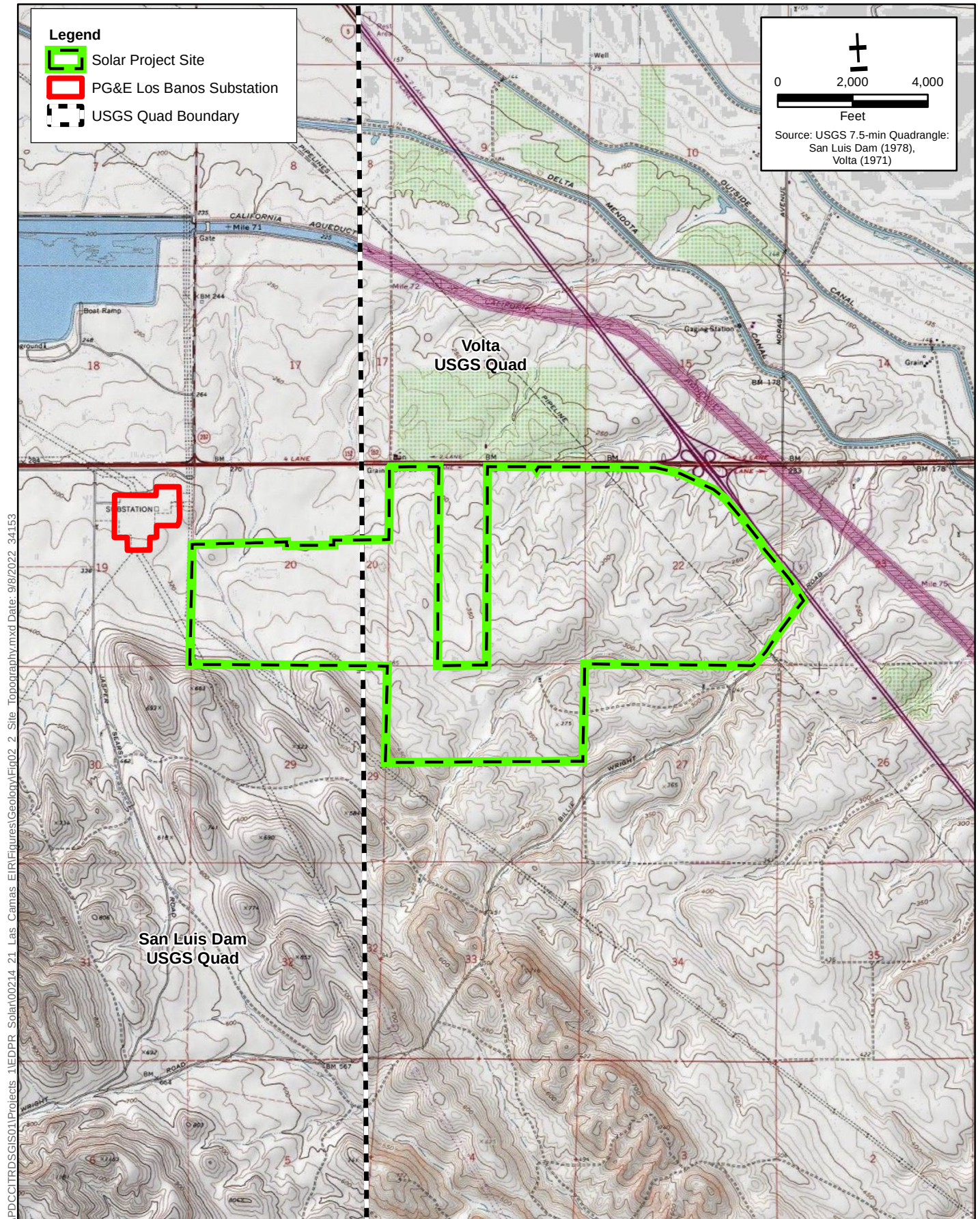


Figure 2-2
Site Topography

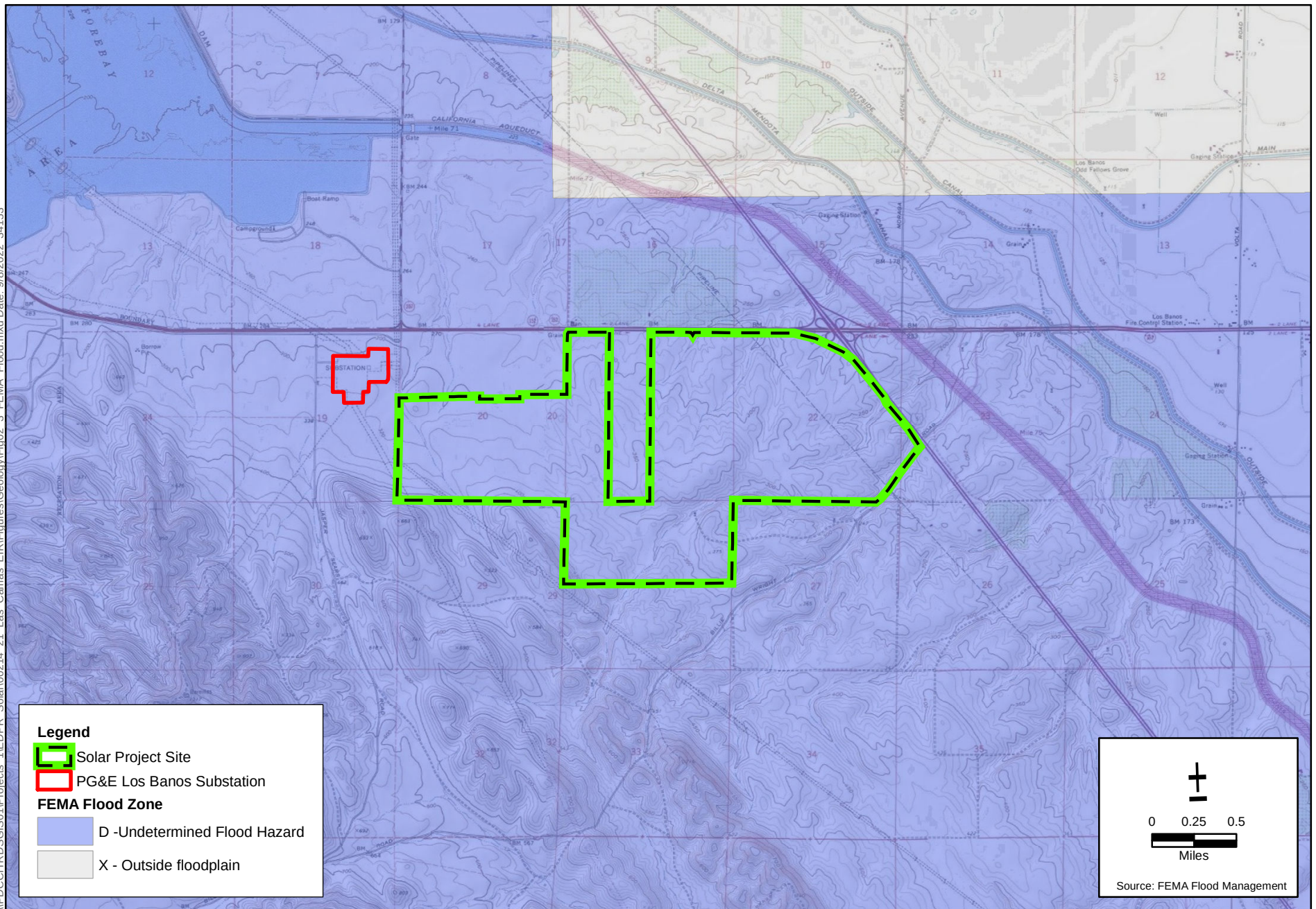


Figure 2-3
FEMA Flood Hazard Zones

2.4 Onsite Soils

According to 2020 RRC preliminary geotechnical report, borings advanced in the field indicated that native soils were encountered beneath approximately 3 to 18 inches of topsoil and extended to a depth of 7 to 9 feet (where bedrock was encountered in two borings) or to the full depth of exploration. Native soils encountered were the following:

- Medium-stiff to very stiff clay, with varying amounts of sand;
- Silt, with varying amounts of sand; and
- Loose to very dense sand, with varying amounts of clay.

According to the Natural Resources Conservation Service's *Web Soil Survey* (Natural Resources Conservation Service 2019), the following descriptions are of the primary soil units located within the solar project site (Figure 2-4):

- **Los Banos clay loam.** The Los Banos series consists of very deep, well-drained soils on terraces and fan remnants. These soils formed in calcareous gravelly alluvium from mixed rock sources and have slow permeability.
- **Apollo clay loam.** The Apollo series consists of deep, well-drained soils formed in material weathered from soft calcareous shale and soft sandstone. Apollo soils are found on low foothills adjacent to valley floors and have moderately slow permeability.
- **Damluis clay loam.** The Damluis series consists of very deep, well-drained soils that formed in alluvium from mixed sources. Damluis soils are on low or uplifted dissected terraces and have slow permeability.
- **O'Neil silt loam.** The O'Neil series consists of moderately deep, well-drained soils on rolling to steep foothills. They soils formed in material weathered from calcareous sandstone and shale and have moderately slow permeability.
- **San Timoteo-Wisflat sandy loams complex.** The San Timoteo series consists of moderately deep, well-drained to somewhat excessively drained soils that formed in material weathered from shale, sandstone, and calcified weathered granite. San Timoteo soils are found on uplands and have moderately rapid permeability. The Wisflat series consists of shallow, well-drained soils on foothills, hills, and mountains. These soils formed in material weathered from sandstone and shale and have moderately rapid permeability.
- **Ballvar loam.** The Ballvar series consists of deep, well-drained soils on alluvial fans. These soils formed in mixed alluvium from sedimentary rock and have moderately slow permeability.
- **Ayar clay.** The Ayar series consists of deep or very deep, well-drained soils that formed in material weathered from decomposed alkaline shales and sandstone on rolling hills and have slow permeability when cracks are closed (December through May).

The primary soil units located within the PG&E substation are Ballvar loam and Damluis clay loam (Figure 2-4).

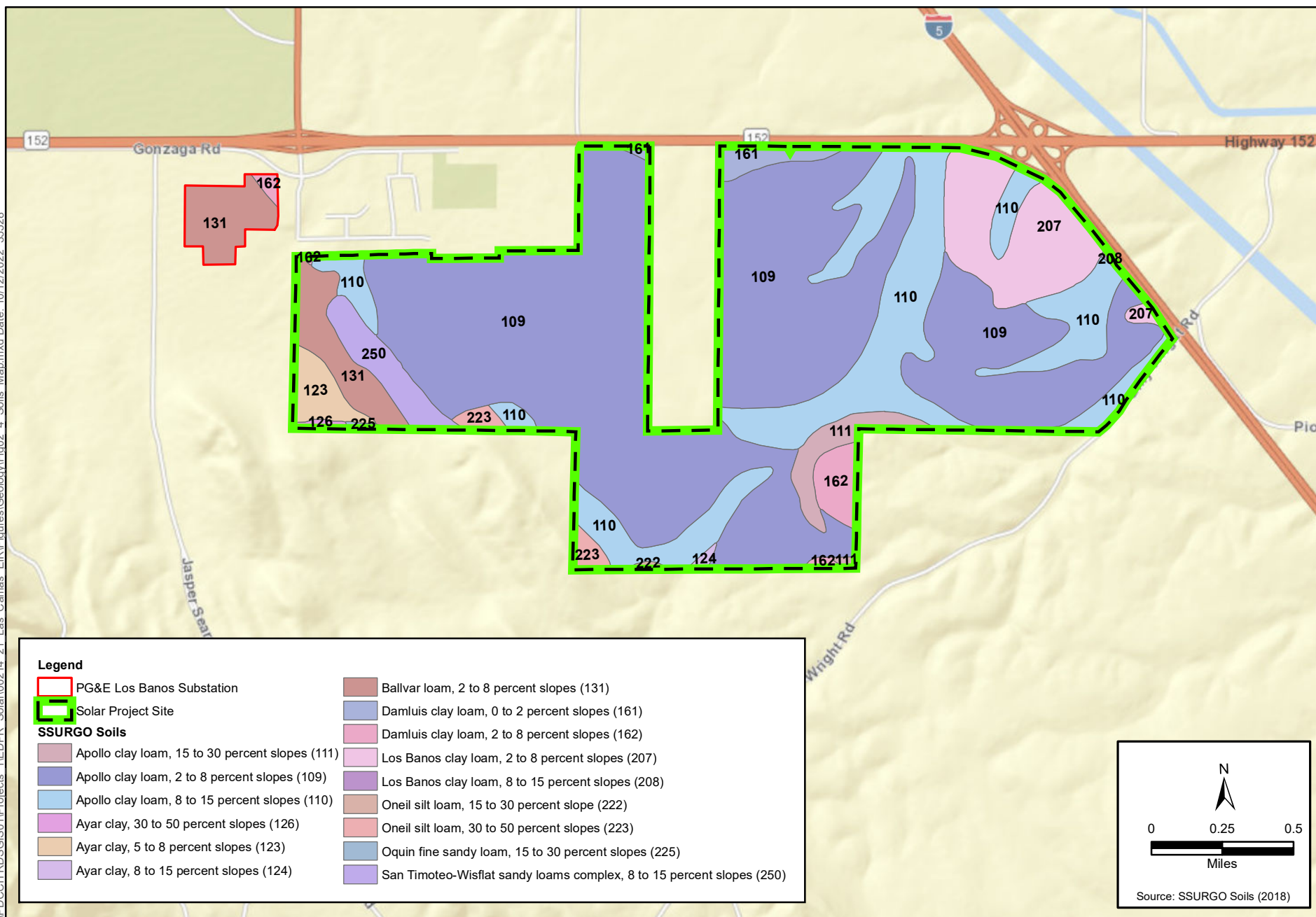


**Figure 2-4
Soil Units**

2.5 Groundwater

The solar project site partially overlies the Delta-Mendota Subbasin (Subbasin). The PG&E substation is within the Subbasin. The Subbasin is in the northwest portion of the San Joaquin Valley Groundwater Basin, within the southern portion of the Central Valley. The Subbasin is bounded on the west by tertiary and older marine sediments of the Coast Range, on the north by the San Joaquin-Stanislaus county line, on the east by the San Joaquin River and Fresno Slough, and on the south by the Tranquility Irrigation District boundary near the community of San Joaquin.

Site-specific depth-to-groundwater measurements were not conducted during preparation of this report. According to the 2020 preliminary geotechnical report, static groundwater levels near the project area were reported to be approximately 16 feet below the ground surface (bgs), with the shallowest groundwater level recorded at 9 feet bgs at a well 1 mile northeast of the solar project site. On-site soil borings were advanced to 20.5 feet bgs during the geotechnical investigation in 2020, and no groundwater was encountered.

According to groundwater measurements taken during a February 2018 preliminary site assessment report (AquaPath 2018) prepared by AquaPath Environmental and Hydrological Consulting for the Forebay Chevron, located at 28960 Gonzaga Road in Santa Nella, static groundwater readings were recorded at 33 and 49 feet bgs. The site is approximately 0.31 mile from the western portion of the solar project site.

No active wells are on the solar project site or the PG&E substation, and no groundwater monitoring has been or is being conducted (CalGEM 2019).

The following chapter describes federal, state, and local geologic hazard and soil regulations applicable to implementation of the proposed project.

3.1 Federal Regulations

Earthquake Hazards Reduction Act

The National Earthquake Hazards Reduction Program (NEHRP) leads the federal government's efforts to reduce the fatalities, injuries, and property losses caused by earthquakes. Congress established NEHRP in 1977, directing that four federal agencies coordinate their complementary activities to implement and maintain the program. These agencies are FEMA, the National Institute of Standards and Technology, the National Science Foundation, and USGS.

The NEHRP agencies pursue the goals of the program through collaboration with each other and numerous partners. In addition to other federal agencies, program partners include state and local governments, universities, research centers, professional societies, trade associations, and businesses as well as associated councils, commissions, and consortia. NEHRP's work encompasses research, development, and implementation activities. Program research helps to advance our understanding of why and how earthquakes occur and affect the natural and built environments. The program develops strategies, tools, techniques, and other measures that can reduce the adverse effects of earthquakes; it facilitates and promotes implementation of these measures, thereby strengthening earthquake resilience among at-risk communities.

3.2 State Regulations

California and Uniform Building Codes

The 2019 California Building Standards Code (Title 24) and the Uniform Building Code provide standards for building construction as well as seismic design parameters and grading requirements. These codes contain specific requirements for seismic safety, excavation, foundations, retaining walls, and all demolition and grading activities. As discussed below, Merced County has adopted the California Building Standards Code under Title 16, Building and Construction, of the Merced County Code.

Alquist-Priolo-Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The purpose of the Alquist-Priolo Geologic Hazards Zones Act, as summarized in the Department of Conservation Division of Mines and

Geology's SP 42, is to "prohibit the location of most structures for human occupancy across the traces of active faults and to mitigate thereby the hazard of fault-rupture." As indicated by SP 42, "the State Geologist...is required to delineate 'Earthquake Fault Zones' (EFZs) along known active faults in California. Cities and counties affected by the zones must regulate certain development 'projects' within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting."

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (1990) addresses non-surface fault rupture hazards such as liquefaction and seismically induced landslides. This act requires the State Geologist to designate Seismic Hazard Zones. These zones of "required investigation" referred to in the California Code of Regulations, Article 10, Section 3722, are areas shown on Seismic Hazard Zone maps where site investigations are required to determine the need for mitigation of potential liquefaction and/or earthquake-induced landslides. The earthquake zones of required investigation nearest to the proposed project are denoted in Figure 3-1.

Construction General Permit

Dischargers whose projects disturb 1 or more acres of soil, or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres, are required to obtain coverage under the General Permit for Discharges of Stormwater Associated with Construction Activity, Construction General Permit Order 2013-0001-DWQ. Construction activities subject to this permit includes clearing, grading, and disturbances to the ground, such as stockpiling or excavation.

The Construction General Permit requires development of a Stormwater Pollution Prevention Plan (SWPPP) by a certified Qualified SWPPP Developer. The SWPPP identifies the best management practices the discharger would use to protect stormwater runoff and incorporates visual, chemical, and sediment monitoring programs.

California Public Utilities Commission General Order 95

California Public Utilities Commission (CPUC) General Order (G.O.) 95 (adopted January 2020) provides general standards for design and construction of overhead electric transmission and distribution lines. Standards include, but are not limited to, rules addressing general arrangement and use of lines, grounding, clearances between electrified portions of lines and the ground or other physical structures, and vegetation management. The intent of these rules is to provide for adequate service and secure safety to persons engaged in the construction, maintenance, operation, or use of overhead lines and to the public in general. The rules are not intended to provide complete construction specifications but to embody the requirements determined to be most important from the standpoint of safety and service.

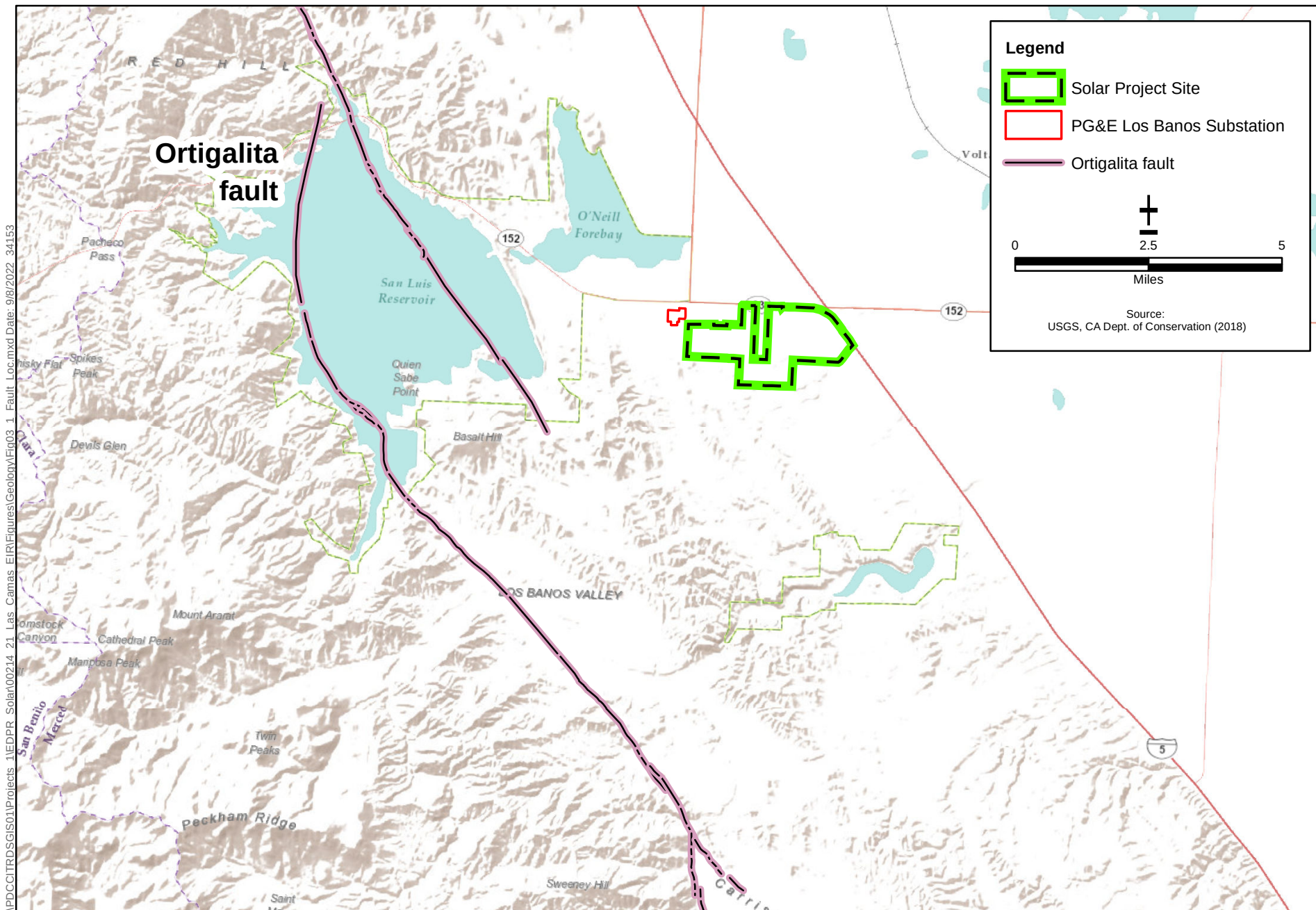


Figure 3-1
Earthquake Zones of Required Investigation

California Public Utilities Commission General Order 174

CPUC G.O. 174, adopted in 2012, provides rules for electric utility substations, including minimum requirements for substation design and construction and for an inspection program for substations. Specifically, G.O. 174 states that “Substations shall be designed, constructed and maintained for their intended use, regard being given to the conditions under which they are to be operated, to promote the safety of workers and the public and enable adequacy of service. Design, construction and maintenance should be performed in accordance with accepted good practices for the given local conditions known at the time by those responsible.” G.O. 174 also specifies that operators of substations must inspect their facilities as frequently as necessary to ensure the safe operation of equipment and components and maintain records of these inspections.

3.3 Local Regulations

Merced County Community and Economic Development Department, Division of Buildings and Safety

The Division of Buildings and Safety oversees and enforces federal, state, and county building codes through the issuance of permits. Operating under the seismic categories defined by the 2019 California Building Standards Code, the County of Merced requires soil reports for all Design Category D building projects, with no exceptions, and soil reports for most building projects in Category C, which, under the division’s estimation, covers the majority of unincorporated areas in the county.

Title 16 Merced County Building and Construction Code

Title 16 of the Merced County Code (Merced County 2021) incorporates the 2019 California Building Standards Code (Title 24) and is applicable to all construction within the unincorporated county. The purpose of Title 16 of the Merced County Code is to protect the public health, safety, and welfare in unincorporated Merced County. It also establishes minimum regulations for the erection, construction, enlargement, alteration, repair, moving, removal, demolition, conversion, occupancy, equipment, use, height, area, and maintenance of all buildings and/or structures; minimum regulations for the installation, alteration, repair, relocation, or replacement of plumbing and drainage systems; and minimum regulations for the installation, alteration, repair, relocation, or replacement of electric wiring, devices, appliances, or equipment within or on any building, structure, or premises in the county, along with associated inspections.

The following portions of Title 24 and corresponding portions of Title 16 govern installation of a solar energy system (Governor’s Office of Planning and Research 2019):

- California Building Code, Title 24, Part 2, Merced County Code Chapter 16.16
- California Electrical Code, Title 24, Part 3, Merced County Code Chapter 16.20

- California Mechanical Code, Title 24, Part 4, Merced County Code Chapter 16.22
- California Plumbing Code, Title 24, Part 5, Merced County Code Chapter 16.24
- California Energy Code, Title 24, Part 6, Merced County Code Chapter 16.26

County Geotechnical Requirements

Local jurisdictions typically regulate construction activities through a multistage permitting process that may require a site-specific geotechnical investigation. The purpose of the investigation is to provide a basis for the development of appropriate construction design. Site-specific geotechnical investigations are to be based on adequate test borings or excavations in the area where construction would occur and prepared by a civil engineer who is registered by the State.

The soils report is to contain required information indicated in the Merced County Improvement Standards and Specifications and the Merced County Storm Drainage Manual. Merced County also requires investigation of the soils underlying proposed areas of grading in conformance with the mandates of the California Building Standards Code.

As discussed on page 1-2, RRC Power & Energy, LLC prepared a geotechnical investigation for the solar project site in 2020.

2030 Merced County General Plan

The 2030 Merced County General Plan Health and Safety Element includes the following goals and policies related to geologic and seismic hazards that are relevant to the proposed project.

- **Goal HS-1:** Minimize the loss of life, injury, and property damage of County residents due to seismic and geologic hazards.
 - **Policy HS-1.7: Hillside Development.** Discourage construction and grading on slopes in excess of 30 percent.
 - **Policy HS-1.8: Grading Standards.** Require that the provisions of the International Building Code be used to regulate projects subject to hazards from slope instability.
 - **Policy HS-1.9: Unstable Soils.** Require and enforce all standards contained in the International Building Code related to construction on unstable soils.

Villages of Laguna San Luis Community Plan

The Villages of Laguna San Luis Community Plan, adopted in September 2008, provides a long-range growth and development plan for approximately 6,200 acres of land located west of I-5 along SR 152 and SR 33 in western Merced County (County 2008). The community design plan includes the following policies that are applicable to the geologic hazards relevant to the proposed project:

- **Goal 2.0:** Development on hillside areas is respectful of environmental and aesthetic qualities and ensures the preservation of public safety.

- **Policy 2.A.1:** Prohibit uniform terraced building sites that are physically contrary to the general configuration of natural topography and require mass grading of the majority of a residential lot.
- **Policy 2.A.2:** Provide variety in the steepness of graded slopes and their configuration.
- **Policy 2.A.3:** Building is not permitted within areas with a slope gradient of more than 30 percent and within other specifically designated hillside areas because of their high visibility from the community, aesthetic appeal, and environmental and safety concerns.
- **Policy 2.A.4:** Grade building sites such that they appear to emerge from the natural terrain and blend into natural landforms.
- **Policy 2.A.5:** Avoid a manufactured or unnatural appearance for graded slopes by creating smooth-flowing contours of varying gradients, preferably with slopes ranging from 2:1 to 5:1.
- **Policy 2.A.6:** Avoid sharp cuts and fills and long linear slopes that exhibit an abnormally uniform grade.
- **Policy 2.A.7:** Soften slope banks by contour grading at the tops and toes of slopes.
- **Policy 2.A.8:** Consider designating areas for permanent open space that are identified as hazardous or unstable through site-specific geotechnical studies.
- **Policy 2.A.9:** Require geologic and geotechnical investigations by licensed geologists and geotechnical engineers for all property planned for development within the 15 percent or greater slope category. Research should determine at a minimum depth to bedrock, bedrock character and stability, soil properties, and potential for landsliding and liquefaction.
- **Policy 2.A.10:** Grade and landscape land in increments of workable size that can be completed during a single construction season.
- **Policy 2.A.11:** Coordinate erosion and sediment control measures with the sequence of grading and construction operations.
- **Policy 2.A.12:** Protect graded sites from both wind and water erosion utilizing accepted slope stabilization methods, which may include retaining walls, hydro-seeding and vegetation applications, erosion netting, soil barrier sediment traps, and dust control sprays.
- **Policy 2.A.13:** Reduce erosion and visual impacts by using sensitively designed terracing retaining walls and landscape design applications that incorporate a wide range of hearty vegetation.
- **Policy 2.A.14:** Limit the height of manufactured slopes to 30 feet between terraces.
- **Policy 2.A.15:** Limit slope gradients to 50 percent or a 2:1 ratio without a soils report and stabilization study indicating a greater permissible slope.

The Villages of Laguna San Luis Community Plan Open Space Plan includes the following goals and policies related to geologic hazards relevant to the proposed project:

- **Goal 1.0:** Natural features and systems are preserved as components of the Community Open Space Plan.
 - **Policy 1.C.1:** Include hillsides with an average slope of more than 30 percent that are not ultimately planned to be part of residential parcels as components of the Open Space System.
 - **Policy 1.C.2:** Consider designating areas for permanent open space that are identified as hazardous or unstable through site-specific geotechnical studies (also Policy 2.A.9 in Community Design Plan).
- **Goal 3.0:** Open space is maintained and enhanced to improve community aesthetics and provide a contrast to developed areas.
 - **Policy 3.A.1:** Maintain prominent hillsides, ridge lines, slopes of more than 30 percent, and major drainage ways for their visual value within and adjacent to the Villages community.

Chapter 4

Faults and Seismicity

The following chapter describes active faults³ in the project area. The Ortigalita fault is the nearest fault to the solar project site and PG&E substation and is considered an active fault (most displacements associated with the Ortigalita fault are characterized as right-lateral, strike-slip movements, with some reverse and normal faulting). The nearest faults of major historical significance to the project area are the San Andreas fault to the west and Calaveras faults to the northwest. Faults of historical significance have been (and are expected to continue to be) the principal sources of seismic activity affecting Merced County (Mintier Harnish 2013). Fault locations are depicted in Figure 4-1.

4.1 Ortigalita Fault

The Ortigalita fault is characterized as a complex zone of reverse-slip, oblique-slip, and right-lateral strike-slip faults with a history of deformation. The fault was divided into four *en echelon*⁴ segments from north to south, the Cottonwood Arm, Los Banos Valley, Piedra Azul, and Little Panoche segments. The solar project site and PG&E substation are nearest to the Los Banos Valley segment of the Ortigalita fault, approximately 5.1 miles to the northwest from the western boundary of the solar project site. This approximately 15-mile segment extends southeastward from San Luis Creek to Carrisalito Flat. Between San Luis Creek and Los Banos Creek, evidence suggestive of recent faulting includes an alignment of springs, right-laterally deflected drainages, scarps, and other features.

The Ortigalita fault is closely aligned with numerous post-1969 earthquakes. The alignment of epicenters is best defined by Little Panoche Valley to San Luis Reservoir. The largest earthquake associated with the Ortigalita fault appears to have been a magnitude⁵ 3.7 event that occurred just south of the San Luis Reservoir in 1981. Most of the seismic activity along the fault from 1969 to 1981 indicated right-lateral, strike-slip movement, although some reverse and normal faulting has occurred at the southern end of the San Luis Reservoir area (Michael W. Manson 1985).

³ A fault that is likely to have another earthquake sometime in the future. Faults are commonly considered to be active if they have moved one or more times in the last 10,000 years.

⁴ Characterized by an approximately parallel formation at an oblique angle to a particular direction.

⁵ According to the *USGS Earthquake Hazards Program* glossary (USGS 2021b), magnitude is a number that characterizes the relative size of an earthquake. Magnitude is based on a measurement of the maximum motion recorded by a seismograph. Several scales have been defined, but the most commonly used are (1) local magnitude (ML), commonly referred to as Richter magnitude; (2) surface-wave magnitude (Ms); (3) body-wave magnitude (Mb); and (4) moment magnitude (Mw). Scales 1–3 have limited range and applicability and do not satisfactorily measure the size of the largest earthquakes. The moment magnitude (Mw) scale, based on the concept of seismic moment, is uniformly applicable to all sizes of earthquakes but is more difficult to compute than the other types. All magnitude scales should yield approximately the same value for any given earthquake.

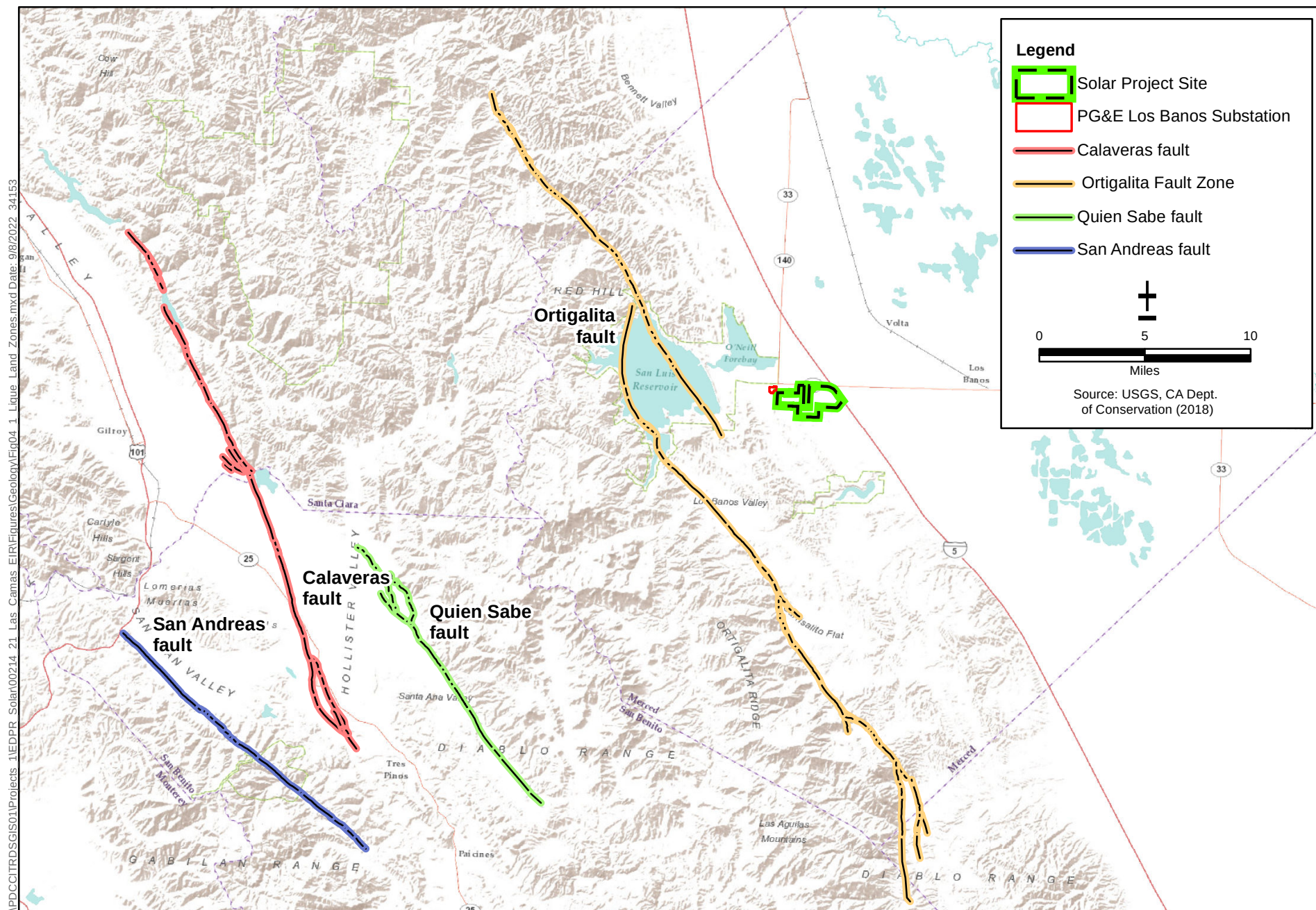


Figure 4-1 Fault Locations

4.2 Quien Sabe Fault

The Quien Sabe fault zone, approximately 20 miles southwest of the solar project site and PG&E substation, is a complex zone of essentially right-lateral, strike-slip faults with a generally down-to-the-west component of vertical displacement. The amount of right-lateral, strike-slip displacement across the fault is unknown. The Quien Sabe fault zone is generally well defined and characterized by late Pleistocene and possible Holocene offset. Late Pleistocene and Holocene alluvium are mapped as offset locally along the Quien Sabe fault, and segments of the fault within the Tres Sisters quadrangle truncate groundwater level contours forming prominent groundwater subbasins.

The Quien Sabe fault zone is seismically active at depth. Furthermore, most of the area between the San Andreas and the Quien Sabe faults is seismically active. Broadly warped surfaces and scattered closed depressions along the fault zone suggest that distributive tectonic deformation occurred in late Quaternary (William A Bryant 1985).

4.3 Calaveras Fault

The Calaveras fault is a major right-lateral, strike-slip fault, approximately 25 miles southwest of the solar project site and PG&E substation, characterized by as much as 15 miles of cumulative late Cenozoic strike-slip displacement. The Calaveras fault has been mapped as concealed by late Pleistocene and Holocene terrace deposits and alluvium along the San Benito River. Segments of the Calaveras fault are well defined and characterized by geomorphic evidence of Holocene faulting, such as closed depressions, right-laterally deflected drainages, scarps and troughs in Holocene terrace deposits and alluvium, right-laterally offset ridges and terrace risers, and tonal lineaments in the latest Pleistocene to Holocene alluvium. Broadly warped surfaces and scattered depressions along the fault suggest that distributive tectonic deformation occurred in late Quaternary time. Significant areas along the Calaveras fault are obscured or concealed by landslides and Holocene terrace and fluvial deposits. The Calaveras fault zone is seismically active at depth (William A Bryant 1985).

4.4 San Andreas Fault

The San Andreas fault is a right-lateral, strike-slip fault and considered the boundary between the North American Plate and the Pacific. It extends from Northern California southward to Cajon Pass near San Bernardino. The San Andreas is the “master” fault of an intricate fault network that cuts through rocks of the California coastal region. The entire San Andreas fault system is more than 800 miles long and extends to depths of at least 10 miles within the Earth. At its closest point to the solar project site and PG&E substation, the San Andreas fault zone is approximately 30 miles to the southwest.

In the 1857 Fort Tejon earthquake, the San Andreas fault ruptured for a distance of 200 miles or more. This earthquake is ranked as one of California's greatest earthquakes, and its magnitude has been estimated as 8.0, ± 0.5 . Based on this estimate, an earthquake of magnitude 8.5 is considered the maximum credible earthquake on this portion of the San Andreas fault. Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 150-year intervals on the southern San Andreas fault. Because the last large earthquake on the southern San Andreas fault occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades (USGS 2016).

Chapter 5

Other Geologic Hazards

The following chapter describes other geologic hazards in the project area, including fault rupture, ground shaking, liquefaction, landslides, soil instability, and expansive soils.

5.1 Fault Rupture

The purpose of the Alquist-Priolo Geologic Hazards Zones Act, as summarized in the Department of Conservation Division of Mines and Geology's Special Publication 42 (SP 42), is to "prohibit the location of most structures for human occupancy across the traces of active faults and to mitigate thereby the hazard of fault-rupture." As indicated by SP 42, the "the State Geologist...is required to delineate 'Earthquake Fault Zones' (EFZs) along known active faults in California. Cities and counties affected by the zones must regulate certain development 'projects' within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting."

The proposed project would not be located in a Fault-Rupture Hazard Zone (California Geological Survey 2021). The nearest Fault-Rupture Hazard Zone is associated with the Ortigalita fault, approximately 5.1 miles northwest of the solar project site. (Figure 4-1). Thus, the proposed project is not expected to cause an indirect or direct adverse effect related to fault rupture because the potential for surface rupture along the solar project site and PG&E substation is considered low.

5.2 Ground Shaking

Ground shaking and secondary effects, including, but not limited to, landslides, ground cracking, and settlement, are possibilities throughout California and depend on local geology and the distance between the project area and the causal fault. Because of the proposed project's location in relation to nearby active faults, the solar project site and PG&E substation are likely to be subject to strong ground shaking in the event of a major earthquake. The closest active fault that could produce seismic shaking in the project area is the Ortigalita fault, approximately 5.1 miles to the northwest. In addition, other fault zones in the area, beyond the Diablo Range, include the Quien Sabe and Calaveras fault zones, approximately 20 and 25 miles, respectively, southwest of the solar project site. Furthermore, the San Andreas fault zone is approximately 30 miles to the southwest.

Compliance with applicable CPUC general orders (as described in Section 3.2, *State Regulations*, above), Merced County building codes, including requirements specific to solar energy systems, would make potentially adverse effects associated with strong seismic ground shaking on the solar project site and PG&E substation unlikely. In addition, the proposed project would not include habitable structures, further reducing potential risks to people and property. None of the

project features are expected to contribute to or exacerbate major geologic phenomena (i.e., strong seismic shaking) that could occur in the area. The 2020 preliminary geotechnical report includes recommendations related to foundation work, slope stability, earth pressures, etc. for the solar project. It considers the area's geologic, soil, and seismic conditions, thereby minimizing the potential effects of seismic ground shaking. The solar project site is identified as suitable for the proposed project, with applicable geotechnical recommendations implemented. Similarly, the PG&E substation improvements would be constructed in accordance with the requirements set forth in the California Building Code and CPUC G.O. 95 and G.O. 174. Thus, implementation of site-specific recommendations, along with adherence to applicable building codes and CPUC orders, would reduce the potential effects of strong ground shaking associated with seismic activity to less-than-significant levels.

5.3 Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced ground shaking. The susceptibility of a site to liquefaction is a function of soil type, the water content of granular sediments, and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silt, sand, and silty sand within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena may include lateral spreading, ground oscillation, loss of bearing strength, subsidence, and buoyancy effects.

Neither the Volta nor the San Luis Dam USGS topographic quad has been evaluated for liquefaction or landslide potential (per the California Geologic Survey). According to the 2030 *Merced County General Plan Background Report*, although no specific liquefaction hazard areas have been identified in the county, the potential for liquefaction exists throughout the San Joaquin Valley because of unconsolidated sediments and a high water table. Conditions for liquefaction are thought to exist in Merced County's wetland areas. The county's wetlands are generally adjacent to the San Joaquin River and extend west to the Union Pacific Railroad and east toward SR 99 and SR 59 south. The solar project site and PG&E substation are not near the San Joaquin River or any substantial wetland area.

Based on available data, shallow groundwater conditions could exist on-site because static groundwater levels near the project area have been reported at approximately 16 feet bgs, with the shallowest measurements recorded at 9 feet bgs northeast of the solar project site. Given its proximity to the solar project site, similar conditions are expected at the PG&E substation. It should be noted that because of subsurface conditions, groundwater levels can vary over time. For example, groundwater depths in the project vicinity (i.e., approximately 0.31 mile from the western portion of the project footprint) have also been identified at 33 and 49 feet bgs. Moreover, primary soil units identified through the Soil Web Survey and soil characteristics identified during the geotechnical investigation identified on-site soils that contained varying amounts of silts and sand, further contributing to potentially liquefiable conditions. However, the 2020 preliminary geotechnical report includes project-specific recommendations related to foundation work, earth pressures, etc., for the solar project. It considers the project area's

geologic, soil, and seismic conditions. Implementation of these recommendations, along with adherence to applicable building codes and the aforementioned CPUC general orders, would minimize the potential effects of seismically related liquefaction to less-than-significant levels.

5.4 Landslides

Landslides generally occur where slopes are steep and/or soils lack cohesiveness. As mentioned, neither the Volta nor the San Luis Dam USGS topographic quad has been evaluated for landslide potential. According to the 2030 *Merced County General Plan Background Report*, the area of greatest concern with respect to slope instability is in the western part of the county, near the Coast Range. This is because of the elevation and instability associated with faulting in the area. The solar project site and PG&E substation are not within or adjacent to areas of significant topographic elevation.

As mentioned in Section 2.3, *Topography and Floodplain*, topography within the solar project site is mostly flat or gently rolling, with an average slope of 4.9 percent. Elevations vary from 450 feet in the southern portion of the site to 250 feet in the northeastern portion of the site (Figure 2-2). Topography at the PG&E substation is generally flat at an elevation of approximately 310 feet above sea level. Therefore, based on information reviewed, the potential for landslides within the solar project site and PG&E substation is considered low.

5.5 Soil Erosion and Loss of Topsoil

Erosion is a condition that could adversely affect development on any site. Construction activities could exacerbate erosion conditions by exposing soils and adding water to the soil from irrigation and runoff from new impervious surfaces. As described previously, any project involving grading of an area greater than 1 acre would be required to obtain coverage under the Construction General Permit. Construction activities covered under the Construction General Permit include clearing, grading, and disturbances to the ground, such as stockpiling, or excavation. The Construction General Permit would require the development and implementation SWPPP, which includes best management practices (BMPs) to regulate stormwater runoff, including measures to prevent soil erosion (typical construction BMPs can include silt fences, straw wattles, sediment traps, gravel sandbag barriers, etc.) and loss of topsoil. Implementation of construction BMPs as part of the SWPPP and the aforementioned CPUC general orders would reduce potential impacts associated with soil erosion and loss of topsoil to less-than-significant.

5.6 Soil Instability

Collapsible soils are those that undergo settlement upon wetting, even without the application of additional load, which occurs when water weakens the bonds between soil particles and reduces the bearing capacity of that soil (known as hydrocompaction). Collapsible soils are typically associated with alluvial fans, windblown materials, or colluvium. Soil collapse can occur when

the land surface is saturated to depths greater than those reached by typical rain events. This saturation eliminates the clay bonds that hold the soil grains together. Land subsidence in California generally occurs in areas where fluid (petroleum and groundwater) removal has occurred; in arid areas, this is due to hydrocompaction of loose near-surface soils (USGS 2017). Land subsidence is a gradual settling or sudden sinking of the surface, owing to subsurface movement of Earth materials.

According to Figure 10-3, Areas of Ground Subsidence within Merced County, in the 2030 *Merced County General Plan Background Report*, the solar project site and PG&E substation are not within an area of historical ground subsidence. The eastern boundary of the solar project site is adjacent to an area of ground subsidence that extends from Los Banos to El Nido; this was due to groundwater withdrawal (Minter Harnish 2013). In addition, research conducted through the Department of Conservation's Geologic Energy Management Division (CalGEM) Well Finder website did not identify the solar project site and PG&E substation as being within or near an oil/gas field or active oil/gas well (CalGEM 2019). Furthermore, the proposed project does not include the installation of oil, gas, or water wells. Because the solar project site and PG&E substation are not located in an area of historical subsidence, or within or near an oil/gas field or active oil/gas well, the potential for soil instability is considered low. In addition, the 2020 preliminary geotechnical report includes recommendations related to foundation work, slope stability, earth pressures, etc. for the solar project. It considers the area's geologic, soil, and seismic conditions. Implementation of these recommendations, along with adherence to applicable building codes and CPUC General Orders 95 and 174, would reduce the potential effects of unstable soils, including the potential for landslides, lateral spreading, subsidence, liquefaction, or collapse, to less-than-significant levels.

5.7 Expansive Soils

Expansive soils are typically composed of clays and can undergo a volume change with changes in moisture content. They have tendencies to expand and soften when wet and harden when dry. If not properly considered prior to the construction of structures, this expansive behavior can damage foundations and other building components. As described in Section 2.4, *Onsite Soils*, multiple primary soil units within the solar project site and PG&E substation contain varying amounts of clay, making soil expansion likely. According to the 2020 preliminary geotechnical report, based on laboratory test results regarding boring, including a plasticity index result of 35⁶ at location TP-01; available geological maps; and literature reviewed during report preparation, highly expansive soils are anticipated to be encountered in some areas of the solar project site. The report identified expansive soil risk as low to moderate in other areas. Given its proximity to the solar project site, similar conditions are expected at the PG&E substation. According to the

⁶ The plasticity index (PI) is one of the standard Atterberg limits used to indicate the plasticity characteristics of a soil and defined as the numerical difference between the liquid limit and plastic limit of the soil. It is the range of water content in which a soil exhibits the characteristics of a plastic solid. Soils that have a high PI have a wide range of moisture content in which the soil performs as a plastic material. Soils with a PI greater than 20 usually have a medium to high swell potential; soils with a PI greater than 35 usually have a very high swell potential. Swelling greatly reduces soil strength.

geotechnical report, shallow foundation systems such as slab-on-grade floor systems or pad foundations for transformers or inverters will require further design considerations if expansive soils are present beneath the foundation bearing elevation. Implementation of geotechnical report recommendations, along with adherence to applicable building codes and CPUC General Orders 95 and 174, would minimize the potential effects associated with expansive soils to less-than significant levels.

Chapter 6

Conclusions and Recommendations

This feasibility-level geotechnical study was developed to identify potential geologic hazards and soil conditions that could result in the proposed project having an adverse effect on the environment. The evaluation was based on available topographic and geologic maps, published geotechnical literature, geologic and seismic data, soil data, groundwater data, and the general geologic conditions and seismic hazards affecting the area. Based on the results of the data reviewed and the nature of the proposed project, implementation of the project is not expected to expose the project features to or exacerbate potentially significant risks associated with seismic activity in the project study area. Furthermore, the proposed project is not expected to result in potential impacts associated with erosion or unstable geologic units. No impacts related to alternate wastewater disposal systems would occur because wastewater would not be generated at the project site. Adherence to applicable building codes and CPUC General Orders 95 and 174, along with recommendations contained in the 2020 preliminary geotechnical report, as outlined in the following recommended measure, would reduce the risk associated with geologic or soil hazards.

Implement Site-Specific Recommendations in a Geotechnical Report for the Solar Project

Prior to construction, a geotechnical report by a qualified, licensed geotechnical engineer should be prepared for the solar project as required by the California Building Code and Merced County. The geotechnical report should include specific structural design recommendations to minimize potential damage to buildings and project infrastructure from seismic events. The study should also make recommendations for foundation work, slope stability, earth pressures, and project design accordingly. The geotechnical report should include recommendations for the building foundation design to accommodate localized settlement under structural footprints related to liquefaction settlement. All appropriate design recommendations included in the geotechnical report should be implemented during the solar project site design and construction phases, in accordance with the County's geotechnical investigation requirements, and subject to County approval prior to the issuance of construction permits. The report should include project design and construction recommendations to address:

- Site preparation and grading, including surface and subsurface prep work, engineered fill materials, fill placement and compaction, trench backfill, and surface drainage;
- Foundation requirements specific to the location of each component of the solar project; and
- Concrete slabs on grade, both interior and exterior, and pavements.

Chapter 7

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