5.6 Geology and Soils

5.6.1 Environmental Setting

Geology and Physiography

The project alignment runs through Merced County, beginning west of Livingston and ending northeast of Livingston, just east of census-designated community of Cressey. The alignment goes through flat agricultural and residential lands, crossing over SR-99 southeast of Livingston. Agricultural uses include orchards, vineyards, field crops, pastures, and dairies. Open fields, landscaping, the Gallo Winery facility, and some light industry are also located along or adjacent to the project route.

Merced County is located in the San Joaquin Valley, the southern portion of the Central Valley of California, and within the Great Valley Geomorphic Province. The largely flat valley floor is composed of alluvial, floodplain, and delta plain deposits fed by intermittent streams originating in the Sierra Nevada to the east, the Coast Ranges to the West, the Cascade Range to the north, and the Tehachapi Mountains to the south. The project alignment is on the south side of the Merced River, beginning and ending within approximately 1 mile of its banks. Ground surface topography is generally flat with an overall slope of 0 to 1 percent, trending uphill from the Gallo Substation at approximately 110 feet to the Cressey Substation at approximately 180 feet.

During the late Mesozoic and Cenozoic, the region existed as a lowland or shallow marine embayment. In the late Cenozoic, much of the area was occupied by shallow brackish and freshwater lakes, particularly in the San Joaquin Valley (PG&E, 2011).

Geologic Setting and Units

The shallowest geologic unit underlying the majority of the project site and vicinity is the Pleistocene-age Modesto formation. The Modesto formation is composed of alluvial and terrace deposits consisting primarily of unconsolidated granitic sands over stratified silts and sands. It has a maximum thickness of approximately 100 feet (PG&E, 2011). Gallo Substation and the western portion of the project route are underlain by eolian sands associated with subdued, stabilized dunes of the upper member of the Modesto formation. Cressey Substation and the eastern portion of the project route are underlain by moderately well-sorted eolian sands of the lower member of the Modesto formation. These upper and lower eolian sand members are interfingered in the central portion of the project route. A small outcropping of the stratigraphically underlying Pleistocene-age Riverbank formation is mapped along the project route approximately 0.75 miles north of its intersection with SR-99. This unit consists of alluvial sand, silt, and gravel. Alluvium of the Riverbank formation also outcrops within a hundred feet north of Cressey Substation (PG&E, 2011).

Soil Types and Hazards

Soil Types

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service has mapped soils in the project area. A summary of the major soil units along the project alignment is presented in PEA Appendix C, which is available for public review at the CPUC Energy Division CEQA Unit and on the project website (http://www.cpuc.ca.gov/Environment/info/aspen/cresseygallo/cresseygallo.htm). The project site surface soils are predominantly mapped as Atwater loamy sand, 0 to 3 percent slopes; Atwater sand, 0 to 3 percent slopes; Delhi sand, 0 to 3 percent slopes; and Delhi loamy sand, 0 to 3 percent slopes. Soils of the Atwater series are present largely in the eastern portion of the project site, and the Delhi series soils are more predominant in the western portion. Smaller areas of both the Delhi and Atwater series with 3 to 8 percent slopes are also present, as well as minor areas of Hilmar loamy sand, Dello sand, and Snelling sandy loam, all with maximum 3 percent slopes (NRCS, 2012).

The Atwater series consists of very deep, porous, well-drained soils formed in granitic alluvium. They are friable, low in organic matter, slightly acidic, and have moderately rapid permeability and slow runoff. They have mixed mineralogy and are uniformly sorted, with a minimum of coarse and very coarse particles (NRCS, 2003). The Delhi series consists of very deep, somewhat excessively drained soils. They formed from wind-modified material weathered from granitic rock sources and are found on floodplains, alluvial fans, and alluvial terraces. They are single-grained, loose, slightly to strongly acidic, and have rapid permeability and negligible to slow runoff (NRCS, 2006).

Expansive and Collapsible Soils

Expansive soils contain significant amounts of clays that expand when wetted. Expansive soils can cause damage to foundations if moisture collects beneath structures. Soils within the project site contain between 0 percent and 20 percent clay (NRCS, 2012), thus the potential for encountering expansive soils throughout the project alignment is low.

Soil collapse occurs when increased moisture causes chemical or physical bonds between the soil particles to weaken, which allows the structure of the soil to collapse and the ground surface to subside. Collapsible soils are generally low-density, fine-grained combinations of clay and sand left by mudflows that have dried, leaving tiny air pockets. When the soil is dry, the clay is strong enough to bond the sand particles together. When the clay becomes wet, moisture alters the cementation structure and the soil's strength is compromised, causing collapse or subsidence. Based on soil type and density, the potential for encountering collapsible soils throughout most of the project alignment is low.

Erosion

Erosion is the process by which rocks, soil, and other land materials are abraded or worn away from the earth's surface over time. The erosion rate depends on many factors, including soil type, geologic parent material, slope, soil placement, vegetation, and human activity. The potential for erosion is highest in loose, unconsolidated soils. The steepness of slopes and absence of vegetation are also factors that increase the natural rates of erosion. Because the topography at the project site is relatively flat, erosion potential is low.

Subsidence

Subsidence is deep-seated settlement due to the withdrawal of fluid (oil, natural gas, or water). Subsidence can sometimes be measured in tens of feet and typically occurs in broad valleys underlain by thick sequences of alluvial sediments. There are various causes of subsidence, most of which happen slowly. The exception is tectonic subsidence, which occurs suddenly as a result of soil compaction due to strong ground shaking during earthquakes. Merced County is most affected by subsidence caused by groundwater withdrawal, hydrocompaction, and earthquakes.

Large parts of the western San Joaquin Valley have been affected by subsidence resulting from extensive groundwater withdrawal that began in the 1920s; ground subsidence reached a maximum of 29.7 feet below historic ground surface levels in 1981 (Ireland, 1986). Subsidence has been mitigated by importation of surface water through major canals and the California Aqueduct in the 1950s through 1970s. By 1983, water levels throughout most of the San Joaquin Valley had recovered to 1940 to 1950 levels, and land subsidence in most of the San Joaquin Valley resulting from groundwater withdrawals seemed to have slowed or stopped (Ireland, 1986). However, average water levels in much of Merced County, including the project area, declined nearly 30 feet from 1970 through 2000 due to groundwater withdrawal (DWR, 2004). Localized areas within the San Joaquin Valley continue to be subject to subsidence due to groundwater withdrawal, and have been mapped in Merced County. The project site is not located within one of these mapped areas (Merced County, 1989).

Hydrocompaction occurs when open-textured soils become saturated with water for the first time, lose strength, and consolidate under their own weight. About 124 square miles of land surface in California has experienced or is subject to subsidence due to hydrocompaction. Hydrocompaction on the west side of the San Joaquin Valley required special consideration and engineering treatment during construction of the California Aqueduct. The Delta-Mendota Canal was built without knowledge of the problem, and subsidence of portions of it has required costly repair (PG&E, 2011).

Tectonic subsidence results in the compaction of loose, non-cohesive soils and could occur in parts of Merced County where the groundwater surface is deep. Loose to medium dense, uniformly graded sands are most susceptible. In areas with shallow groundwater, liquefaction is more likely in the event of significant seismic shaking. The potential for ground subsidence due to earthquake motion is largely dependent on the magnitude, duration, and frequency of the earthquake waves. Probable seismic ground shaking for the site is expected to be minimal, as calculated in Section 5.6.1, Ground Motion; therefore, tectonic subsidence is also anticipated to be minimal.

Landslides

A landslide is defined as the slipping down or flowing of a mass of land (rock, soil, and debris) from a mountain or hill. Landslide potential is high in steeply sloped areas underlain by alluvial soils, thinly bedded shale, or bedrock where the bedding planes are oriented in an out-of-slope direction (bedding plane angles that are greater than horizontal, but less than the slope face).

There is a low probability for landslides in the project area because of the relatively flat (0 to 1 percent slope) topography and distance from hills, mountains, or slopes. The project site is not located within a landslide hazard area, as indicated by the Merced County General Plan (2011).

Several irrigation canals are located along the project site route, the largest being Livingston Canal. The route crosses the canal between Mercedes Avenue and Eucalyptus Avenue along Arena Way. These canals are largely concrete-lined and the possibility that localized sloughs, slumps, or other failures along the canal banks could result from seismic events, weather, or high water is minimal.

Seismicity and Faults

The Alquist-Priolo Earthquake Fault Zoning Act designates earthquake fault zones based on the presence of a sufficiently active and well-defined fault. The California Geological Survey (CGS) developed criteria to classify fault activity for the Alquist-Priolo Earthquake Fault Zoning Act. An active fault is one that is "sufficiently active and well-defined," with evidence of surface displacement within Holocene time (about the last 11,000 years) (Hart and Bryant, 2007).

There are no designated Alquist-Priolo faults in the immediate project area (CGS, 2011). The only known active fault within Merced County is the Ortigalita fault, also known as the Tesla-Ortigalita fault, a north-northwest-striking, right-lateral strike-slip fault located approximately 25 miles from the western end of the project site. The USGS Quaternary fault map indicates that sections of the Ortigalita fault have been active within the last 15,000 years (USGS, 2006). The CGS fault activity map indicates the Ortigalita fault has been active within the last 11,700 years (DOC, 2010). Other faults and fault zones in proximity to the site include right lateral strike-slip faults associated with the San Andreas fault system, the Foothills fault system, and the Coast Range-Sierran Block Boundary Zone (CRSB). Fault rupture potential in the project area is considered low.

Ground Motion

An earthquake along any of the fault zones listed in Appendix C is capable of generating ground motion or shaking along the Proposed Project alignment. The project alignment is located in a region that is expected to undergo low to moderate earthquake shaking (CGS, 2011).

Approximate peak ground acceleration (PGA) was estimated for the project alignment using the CGS Probabilistic Seismic Hazard Assessment (PSHA) online tool and the USGS Earthquake Ground Motions Tool (CGS, 2011; USGS, 2008). The PGA presented in Table 5.6-1 represents a 10 percent probability of being exceeded during a 50-year period. They are expressed as a fraction of the acceleration due to gravity (g). The values were obtained for the western end of the project site at Longitude 120.785 and Latitude 37.368 for firm rock, soft rock, and alluvium. According to available information and the calculated PGA values below, the project site would likely be categorized as alluvium, PGA of 0.239 g. This is considered a low to moderate value for the state. PGA values across California range from about 0.1 g to over 1.0 g. More than three-fourths of the population of the state resides in counties with seismic hazard calculated to be above 0.4 g (PG&E, 2011).

Table 5.6-1. Peak Ground Acceleration In the Project Area

Ground Motion	Firm Rock	Soft Rock	Alluvium
Peak ground acceleration (PGA)	0.178 g	0.194 g	0.239 g

Liquefaction

Liquefaction is a phenomenon in which water-saturated, cohesionless sediments, such as sand and silt, temporarily lose their strength and liquefy. Liquefaction occurs when saturated sediments are subjected to dynamic forces, such as intense and prolonged ground shaking during an earthquake. Liquefaction typically occurs when groundwater is shallow (i.e., less than 50 feet below ground surface) and soils are predominantly granular and unconsolidated. Effects of liquefaction on level ground can include sand boils, settlement, and bearing capacity failures below structural foundations.

Regional groundwater data from nearby wells collected from the DWR and the California State Water Resources Control Board (SWRCB) websites indicate that the groundwater table along the project alignment is on the order of 45 to 85 feet below ground surface (PG&E, 2011). Additionally, the General Plan indicates the project site does not fall within an area mapped as having a high water table, defined as within 20 feet of the ground surface (Merced County, 1989). Sandy and silty soils comprise the majority of the soils underlying the project site, and localized areas of silty clay may allow groundwater to collect at higher levels in the substrata. The introduction of water to the site through irrigation or excessive rainfall may increase the potential for liquefaction. Specific liquefaction hazard areas have not been identified in Merced County; however, this potential exists in areas of the San Joaquin Valley where unconsolidated sediments and a high water table coincide (PG&E, 2011).

Regulatory Setting

The following regulations apply to soil and geologic risks and impacts in the project area.

Alquist-Priolo Earthquake Fault Zoning Act (P.R.C. § 2621 et seq.). This Act prohibits the location of most types of structures for human occupancy across the active traces of faults in earthquake fault zones shown on maps prepared by the state geologist. It also regulates construction in the corridors along active faults.

Seismic Hazards Mapping Act of 1990 (P.R.C. § 2690–2699.6). Under the provisions of this act, the state is charged with identifying and mapping areas at risk of strong ground shaking, liquefaction, seismically induced landslides, and other related hazards. These maps are to be used by cities and counties in preparing their general plans and adopting land use policies in order to reduce potential public hazards.

Uniform Building Code (UBC). The UBC sets forth design codes to improve the capacity of structures to withstand seismic hazards. Published and periodically updated by the International Conference of Building Officials (ICBO), it covers earthquake provisions (Chapter 16), foundations and retaining walls (Chapter 18), and excavation and grading (Chapter A33). In California it is referred to as the California Building Code (CBC). Seismic site factors are derived from the UBC/CBC and are required by state and local agencies in geotechnical investigations for critical structures in areas of high seismicity.

California Public Utility Company (CPUC) General Order 95. General Order 95 defines safe practices for utility poles and wiring.

Applicant Proposed Measures

PG&E proposes to implement measures during the design, construction, and operation of the Proposed Project to ensure it would occur with minimal environmental impacts in a manner consistent with applicable rules and regulations. Applicant Proposed Measures (APMs) are considered part of the Proposed Project in the evaluation of environmental impacts. CPUC approval would be based upon PG&E adhering to the Proposed Project as described in this document, including this project description and the APMs, as well as any adopted mitigation measures identified by this Initial Study (see Table 5.6-2).

Table 5.6-2. Applicant Proposed Measures (APMs) Related to Geology and Soils

APM Number	Issue Area
	Geology and Minerals
APM GM-1	Appropriate Design Measures Implementation. Based on available references, sands and loamy sands are the primary soil types expected to be encountered in the graded and excavated areas as project construction proceeds. Potentially problematic subsurface conditions may include soft or loose soils. Where soft or loose soils are encountered during design studies or construction, appropriate measures will be implemented to avoid, accommodate, replace, or improve soft or loose soils encountered during construction. Such measures may include the following: ▪ Locating construction facilities and operation away from areas of soft and loose soil. ▪ Over excavating soft or loose soils and replacing them with non-expansive engineered fill. ▪ Increasing the density and strength of soft or loose soils through mechanical vibration and/or compaction. ▪ Treating soft or loose soils in place with binding or cementing agents. ▪ Construction activities in areas where soft or loose soils are encountered may be scheduled for the dry season, as necessary, to allow safe and reliable equipment access.

Table 5.6-2. Applicant Proposed Measures (APMs) Related to Geology and Soils

Hydrology and Water Quality	
APM WQ-1	SWPPP or Erosion Control Plan Development and Implementation. Following project approval, PG&E will prepare and implement a SWPPP, if required by state law, or erosion control plan to minimize construction impacts on surface water and groundwater quality. Implementation of the SWPPP or erosion control plan will help stabilize graded areas and reduce erosion and sedimentation. The plan will designate BMPs that will be adhered to during construction activities. Erosion and sediment control measures, such as straw wattles, covers, and silt fences, will be installed before the onset of winter rains or any anticipated storm events. Suitable stabilization measures will be used to protect exposed areas during construction activities, as necessary. During construction activities, measures will be in place to prevent contaminant discharge. The project SWPPP or erosion control plan will include erosion control and sediment transport BMPs to be used during construction. BMPs, where applicable, will be designed by using specific criteria from recognized BMP design guidance manuals. Erosion-minimizing efforts may include measures such as the following: ▪ Defining ingress and egress within the project site ▪ Implementing a dust control program during construction ▪ Properly containing stockpiled soils Erosion control measures identified will be installed in an area before construction begins during the wet season and before the onset of winter rains or any anticipated storm events. Temporary measures such as silt fences or wattles, intended to minimize sediment transport from temporarily disturbed areas, will remain in place until disturbed areas have stabilized. A copy of the SWPPP or erosion control plan will be provided to the CPUC prior to construction for recordkeeping. The plan will be updated during construction as required by the SWRCB.

5.6.2 Environmental Impacts and Assessment

GEOLOGY AND SOILS Would the project:	Potentially Significant Impact	Less than Significant With Mitigation Incorporated	Less than Significant Impact	No Impact
a. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☒	☐
ii) Strong seismic groundshaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☒	☐
iv) Landslides?	☐	☐	☒	☐
b. Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c. Be located on geologic units or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

Significance criteria established by CEQA Guidelines, Appendix G.

a. Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42; ii) Strong seismic ground shaking; iii) Seismic-related ground failure, including liquefaction; or iv) Landslides?

LESS THAN SIGNIFICANT IMPACT. (i) No known active faults underlie the project alignment and there currently are no designated Alquist-Priolo faults in the immediate project area. Therefore, there are no impacts associated with the potential rupture of a known fault.

(ii) Seismic ground shaking on the project site may occur because of earthquakes generated on faults at the western margin of the Central Valley, such as the Ortigalita fault described above; however, the project facilities would be engineered per standards to withstand potential ground shaking in accordance with the CPUC's General Order 95 and would meet or exceed the relevant seismic requirements. In addition, the distance of the identified faults from the proposed transmission line alignment suggests that should a seismic event occur, the proposed transmission line infrastructure would be affected by relatively low ground acceleration. Proper design would reduce the threat of damage to the proposed facilities from the potential maximum ground acceleration to less than significant levels. Potential impacts associated with seismic events such as ground shaking would be less than significant.

(iii) The project would be located in an area of low liquefaction potential, thereby resulting in a less-than-significant impact.

(iv) Because of relatively flat topography, there would be no potential for landslides in the project area; therefore, no impact would occur due to landslides.

b. Would the project result in substantial soil erosion or the loss of topsoil?

LESS THAN SIGNIFICANT IMPACT. Ground disturbance would result from preparing new pole and tower sites, augering holes for new pole and tower foundations, reestablishing select access roads, and use of existing access roads that are not paved. During construction, grading activities would be conducted at Cressey and Gallo Substations, 0.1 acres, and in specific areas along the site route to create new orchard access roads, 0.2 miles of new road. At staging areas, minor scraping would be required to achieve an even grade or to remove any weeds that may be present. Best Management Practices (BMPs) would be implemented to minimize and avoid surface runoff, erosion, and pollution, including but not limited to the following: locate construction facilities and operation away from areas of soft and loose soil; over excavate soft or loose soils and replace them with non-expansive engineered fill; increase the density and strength of soft or loose soils through mechanical vibration and/or compaction; treat soft or loose soils in place with binding or cementing agents; and schedule construction activities in areas where soft or loose soils are encountered for the dry season, as necessary, to allow safe and reliable equipment access.

Stockpiles would be located away from or down-gradient of waterways in accordance with the Storm Water Pollution Prevention Plan (SWPPP) or erosion control plan that would be prepared for the project in accordance with APM WQ-1. APM WQ-1 would ensure that an erosion control plan that is comparable to a SWPPP per the federal Clean Water Act would be implemented if it is determined that the project would not affect jurisdictional waterways. In addition, APM WQ-1 would ensure that the erosion control plan would include BMPs comparable to what would be included in a SWPPP, as summarized above. Sediment control BMPs would be implemented to manage temporary stockpiles.

Because the project site is relatively flat, minimal ground disturbance would be required, and implementation of APM GM-1 and APM WQ-1 (see also Section 5.9) would be required to minimize erosion, impacts from erosion or topsoil loss would be less than significant.

c. Would the project be located on geologic units or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?

LESS THAN SIGNIFICANT IMPACT. Mapped soils in the project area are primarily unconsolidated sands and loamy sands, which could be subject to subsidence. Appropriate design measures would be implemented to avoid, accommodate, replace, or improve any problematic soft or loose soils encountered during construction. The implementation of APM GM-1 would ensure impacts would be less than significant by requiring appropriate design measures including the following: locating construction facilities and operation away from areas of soft and loose soil; over excavating soft or loose soils and replacing them with non-expansive engineered fill; increasing the density and strength of soft or loose soils through mechanical vibration and/or compaction; treating soft or loose soils in place with binding or cementing agents; and scheduling construction activities in areas where soft or loose soils are encountered for the dry season, as necessary, to allow safe and reliable equipment access. The project construction, operation, and maintenance would not include or require that groundwater wells be constructed for the purpose of water extraction and use, so the project would not result in any impact from subsidence associated with groundwater withdrawal.

The depths to groundwater across the project area minimize the likelihood of liquefaction, as do the low to moderate peak ground accelerations for the site. Although localized areas of silty clay in the project area may allow groundwater to collect at higher levels in the substrata, the potential for surface manifestations of liquefaction would be low and the potential impact on the project would be minimal. The project construction, operation, and maintenance would not require that significant amounts of water be introduced into the subsurface soils; therefore, the project would have no impact on the liquefaction potential of the site.

d. Would the project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?

NO IMPACT. The project is not located in an area with identified expansive soil; therefore, no impact would occur.

e. Would the project have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater?

NO IMPACT. No septic tanks or alternative wastewater disposal systems (e.g., leach fields) would be constructed as part of the project. No impact would occur.