8 GEOLOGY, SOILS, MINERAL RESOURCES, AND PALEONTOLOGY

8.1 INTRODUCTION

This section describes existing conditions in the vicinity of Pacific Gas and Electric Company's (PGandE) Delta Distribution Planning Area Capacity Increase Substation Project (project) in terms of geology, soils, mineral resources, and paleontology, and the related impacts that may occur due to project implementation. Potential geologic hazards, including fault-surface rupture, ground shaking, landsliding, lateral spreading, and other ground-failure mechanisms are addressed, as well as soil engineering properties relevant to the project. Based on evaluation of the geology, soils, mineral, and paleontological resources that occur in the project vicinity and the characteristics of the project, impacts to these resources will be less than significant.

8.2 METHODOLOGY

Information on geology, soils, minerals, and paleontological resource conditions in the project vicinity was compiled from existing published and unpublished literature, maps, and data. The area has been well studied and documented by various researchers and government entities, including the U.S. Geologic Survey (USGS), the California Geological Survey (formerly California Division of Mines and Geology), the U.S. Soil Conservation Service, and others.

8.3 EXISTING CONDITIONS

8.3.1 Geologic Setting

The project is located in the eastern San Francisco Bay region on the boundary between the Coast Ranges and the Great Valley Geomorphic Province of California. Geologically, the Great Valley Geomorphic Province consists of a deep, northwest-trending sedimentary basin that borders the east side of the Coast Ranges. The Great Valley Geomorphic Province is referred to north of the site as the Sacramento Valley and as the San Joaquin Valley south of the site. The Sacramento and San Joaquin valleys drain into the Pacific Ocean through a gap in the Coast Ranges at San Francisco Bay. The Coast Ranges consist of a sequence of northwest-trending mountains and valleys, aligned to and adjacent to the California coastline. Geologically, the Coast Ranges are comprised of a series of fault-bounded tectonic blocks. All of the boundary faults between the blocks are part of the overall San Andreas Fault system (Wagner, 1990). The San Andreas Fault system is the major active fault system in California and is the boundary between two major parts of the earth's crust, the North American plate and the Pacific plate. The relative movement between these two plates causes the earthquakes that occur along the San Andreas and related faults. The San Andreas Fault Zone occurs approximately 72 kilometers west of substation site C at its closest point. Other faults associated with the San Andreas Fault system plate boundary, including the Hayward Fault Zone, the Concord Fault, the Greenville Fault, and others, occur closer to the site as described below.

The project area occurs in the lowermost portion of the foothills east of Mount Diablo at the northern end of the Diablo Range (part of the larger Coast Ranges). The project site will be located in a small Quaternary alluvium-filled valley (Lone Tree Valley) that drains from west to east through the low foothills toward the north end of the San Joaquin Valley.

The Quaternary alluvium exposed at the surface in the site vicinity has been mapped as Holocene (11,000 years ago to present) in age (Helley and Graymer, 1997). At depth below the surface, it is likely Pleistocene (2 million years ago to 11,000 years ago) in age and has been mapped as such by some investigators (Helley and Lajoie, 1979). Based on 1:75,000-scale mapping of bedrock exposures near the southern end of the substation parcel and on 1:24,000-scale USGS topographic mapping, it is estimated that the thickness of alluvium beneath the substation parcel ranges from practically non-existent at the south property line to approximately 100 feet at the north property line. Design-level engineering studies will provide more specific information on the thickness of alluvium in the project area.

The alluvium beneath substation site C is underlain by the lower member of the Eocene (55 to 38 million years ago) Markley Formation, with bedding dipping generally northward at about 12 degrees. This bedrock member is described in literature as a thin-bedded to massive sandstone with minor siltstone and mudstone. Beneath this member is a thick sequence of marine and non-marine sedimentary bedrock units of Tertiary (63 to about 2 million years ago) to Jurassic age (205 to 138 million years ago). These bedrock units are exposed in the higher foothills and on the eastern flank of the Diablo Range east of the site, and are underlain by basement consisting of the Jurassic Coast Range Ophiolite, presumably in fault contact with underlying Franciscan Complex (Graymer et al., 1994).

8.3.2 Faulting and Seismicity and Related Hazards

There are no known active faults in the immediate vicinity of substation site C, so the hazard of direct surface displacement by faulting is very low. However, ground motion due to earthquakes on faults located distant from the site is a potential hazard since the overall site region is seismically active. Earthquakes have occurred in historic time with surface displacement on the San Andreas Fault Zone, the Hayward Fault Zone, the Concord Fault, the Greenville Fault, the Calaveras Fault, and other minor faults in the region (Jennings, 1994). In addition, there have been earthquakes in historic time associated with movement along faults at depth without surface displacement.

Table 8-1 summarizes the key characteristics of the major active faults that occur within approximately 70 kilometers of the project site. The approximate 70-kilometer search radius was selected specifically to include the main San Andreas Fault Zone. Active faults are those that show evidence of movement within Holocene time (last 11,000 years).

Considering active faults throughout the region, the California Geological Survey has published maps of estimated probabilistic ground accelerations for the region. At the project site, 0.4g (where "g" is the acceleration due to gravity) is the estimated peak horizontal ground acceleration with a 90 percent probability of not being exceeded in 50 years (California Geological Survey, 2004). This probabilistic horizontal ground acceleration has an approximate 1 in 475 probability of occurrence each year.

Table 8-1: Known Active Faults within 70 Kilometers

Fault	Approximate Distance and Direction to Closest Surface Trace (km)	Length (km)	Slip Rate (millimeters per year)	Maximum Earthquake Magnitude[1]
Greenville Fault (north segment)	12 W	27	2	6.6
Concord Fault	22 WSW	17	4	6.2
Calaveras Fault (northern segment)	27 WSW	45	6	6.8
Greenville Fault (south segment)	29 S	24	2	6.6
Green Valley Fault (south segment)	31 WNW	25	5	6.2
Hayward Fault Zone (southern segment)	42 WSW	52	9	6.7
Hayward Fault Zone (northern segment)	44 W	35	9	6.4
Green Valley Fault (north segment)	50 NNW	14	5	6.2
West Napa Fault	50 NW	30	1	6.5
Calaveras Fault (central segment)	58 SSW	59	15	6.2
Rodgers Creek Fault Zone	64 WNW	62	9	7.0

Fault	Approximate Distance and Direction to Closest Surface Trace (km)	Length (km)	Slip Rate (millimeters per year)	Maximum Earthquake Magnitude[1]
San Andreas Fault Zone (peninsula segment)	72 WSW	85	17	7.1
Mount Diablo Blind Thrust	---	25	2	6.6
Great Valley 5 Blind Thrust	---	28	1.5	6.5
Great Valley 7 Blind Thrust	---	45	1.5	6.7

Sources: Jennings, 1994; Tianqing et al., 2003

km	kilometers
W	west
WSW	west-southwest
S	south
WNW	west-northwest
NNW	north-northwest
NW	northwest
SSW	south-southwest
---	not applicable. Blind thrust faults do not have a surface trace. The distance from the site to the fault plane was not determined for this study, but these faults were considered in the probabilistic ground-shaking seismic hazard analysis described below.

[1] Maximum moment magnitude with a 90 percent probability of not being exceeded in 50 years.

There are no unstable geologic units in the project area. There has not historically been substantial subsidence in the project area (Helley and Lajoie, 1979). The geologic units in the project area are not highly susceptible to liquefaction (Knudsen, et al., 2000), and the likelihood of liquefaction occurring in the project area due to large earthquakes on the major regional fault systems is moderately low to very low (Association of Bay Area Governments, 2004).

8.3.3 Soils

The substation site and access road are on relatively flat ground in an area of soils belonging to the Rincon Series of the Capay-Rincon Soil Association as mapped by the U.S. Department of Agriculture Soil Conservation Service. This soil series consists of well-drained soils that formed in alluvial fill derived from sedimentary rock.

The soil type at the substation, interconnection, and access road alignment is Rincon clay loam, which occurs in nearly level areas. Runoff and permeability are slow, and the hazard of erosion is none to slight where the soil is disturbed. The profile typically consists of:

- an approximate 12-inch-thick surface layer of dark grayish-brown neutral clay loam,
- an approximate 17-inch-thick upper subsoil of brown neutral or mildly alkaline clay,
- an approximate 9-inch-thick lower subsoil of yellowish-brown, moderately alkaline silty clay loam, and
- the substratum is light yellowish-brown, moderately alkaline, silty clay loam and heavy loam, and extents to a depth of more than 60 inches.

The Rincon soil series is montmorillonitic. The upper subsoil horizon (12 to 29 inch depth) has a high shrink-swell potential. The surface horizon and lower subsoil horizon have a moderate shrink-swell potential.

8.3.4 Mineral Resources

The project area is currently used for open space and agriculture. There are no known important mineral resources in the immediate vicinity, nor are there active mining operations. The California Surface Mining and Reclamation Act of 1975 requires that the State Geologist classify land into mineral resource zones (MRZ) according to the known or inferred mineral potential of the land. The site location is classified as MRZ-1 (Kohler-Antablin, 1996), which means that there is adequate information on mineral resources in the area to indicate that no significant mineral deposits are present, or where it is judged by the State Geologist that little likelihood exists for their presence.

8.3.5 Paleontology

The majority of the substation site is located on alluvial fan and fluvial deposits of Holocene age. It is likely that underlying these Holocene sediments in the vicinity of the substation site are Pleistocene (2 million to 11,000 years old) alluvial sediments, although their depth is unknown. Directly south of the site, where there will be excavation for tower construction, there are outcrops of marine sedimentary rocks that are part of the Eocene Markley Formation.

The University of California Museum of Paleontology (UCMP) databases of known paleontological sites in Contra Costa County (County) have been reviewed to identify the occurrence of fossils in these three formations and to determine the likelihood that paleontological resources might be impacted during excavation and grading of the site.

8.3.5.1 Holocene Alluvial Fan Deposits

A literature search and search of the UCMP database identified only one vertebrate fossil (*Mammalia bison*) discovery in the alluvial sediments of Holocene age in the far western part of the County. This formation is comprised of the most recent sediments (less than 11,000 years old) that have been deposited in the Lone Tree Valley. These sediments are primarily comprised of medium-dense to dense, gravely sand that generally grade upward to sandy and silty clay. These Holocene sediments are unlikely to contain any significant fossil resources.

8.3.5.2 Pleistocene

A similar search of the UCMP database did identify occurrences of fresh water mollusks and Pleistocene vertebrate fossils in Pleistocene alluvial sediments in the County. Many of the localities of fossil discoveries are in the western and northern portions of the County near San Pablo Bay and Suisun Bay. The closest site demonstrated from the UCMP database is approximately 5 kilometers north of the site and includes a number of Pleistocene fossils (*Mammalia bison, Mammalia equus, Mammalia taxidea, and Mammalia odocoileus*).

8.3.5.3 Eocene Markley Formation

While the largest portion of the substation site is located on the Holocene Quaternary alluvial deposits, excavation on the southern end of the project area, and excavation associated with Towers 1 and 2 to the south of the site will likely intersect Markley formation. The Markley Formation consists of sediments deposited in a marine environment conducive to preservation of marine fossils. Fossil discoveries from the Markley Formation have been made in Contra Costa County. Searches in the UCMP database indicate fossil localities for both vertebrate and invertebrate fossils from the Markley Formation; however, no significant discoveries appear to have been made in the vicinity of the site.

8.4 IMPACTS

8.4.1 Significance Criteria

Standards of significance were derived from Appendix G of the California Environmental Quality Act (CEQA) Guidelines.

8.4.1.1 Geology

Impacts to geology may be considered significant if they:

- result in severe damage or destruction to one or more project components as a direct consequence of a geologic event,

- result in exposure of people or structures to potential substantial adverse effects, including the risk of loss, injury or death involving:

  – rupture of a known earthquake fault,
  – strong seismic ground shaking,
  – seismic-related ground failure, including liquefaction, or
  – landslides, or

- are located on a geologic unit that is unstable, or that would become unstable as a result of the project, and potentially result in on-site or off-site landsliding, lateral spreading, subsidence, liquefaction, or collapse.

8.4.1.2 Soils

Impacts to soils may be considered significant if they:

- result in a substantial soil erosion or loss of topsoil,

- are located on a soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-site or off-site landsliding, lateral spreading, subsidence, liquefaction, or collapse, or

- create a substantial risk to life or property due to the presence of expansive soils.

CEQA also includes the potential for consideration of significant impacts due to the presence of soils incapable of supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available; however, this consideration is not applicable to the project because no sanitary wastewater will be produced.

8.4.1.3 Mineral Resources

Impacts to mineral resources may be considered significant if they:

- result in the loss of availability of a known mineral resource classified MRZ-2 by the State Geologist and of value to the region and residents of the state, or
- result in the loss of availability of a locally important mineral resource recovery site.

8.4.1.4 Paleontological Resources

Impacts to paleontological resources may be considered significant if they result in physical changes to the landscape, directly affecting or changing the context within which a paleontological resource or unique geologic feature exists.

8.4.2 Construction

8.4.2.1 Geology

The project includes construction of a new substation and related distribution circuit outlets and transmission loop, and an access road. The construction period will be approximately eight months. Engineering-level geotechnical studies will be completed to assure that the project design adequately accounts for geologic conditions. Considering these factors, the following geologic hazards were evaluated for construction impacts.

8.4.2.1.1 Fault Rupture

There are no Alquist-Priolo fault zones and no active surface-fault traces in the project area. Therefore, the potential for surface-fault rupture to affect the project is less than significant and no impact is expected.

8.4.2.1.2 Strong Ground Shaking and Related Effects

Various faults in the area are capable of generating strong ground shaking in the project area but the likelihood for strong ground shaking during the short construction period is low. Project facilities will be engineered to withstand expected ground motions without substantial adverse affects. As described in Section 8.3 Existing Conditions, the potential for liquefaction in the project area is moderately low to very low.

The project will be located in relatively flat terrain and conditions prone to lateral spreading, landslides, and other seismically induced ground failures do not occur. Based on these considerations, any impacts related to ground shaking would be less than significant. This includes direct (i.e., shaking) and secondary effects of ground shaking, including seismically induced liquefaction, lateral spreading, landslides, and other ground failures. Considering these factors, the potential for an impact due to strong ground shaking is less than significant.

8.4.2.1.3 Landslides

The project is located in a relatively flat area so slope stability risks are not a significant concern and no impact is expected.

8.4.2.1.4 Unstable Geologic Units

There are no unstable geologic units in the project area and, therefore, no impact is expected.

8.4.2.1.5 Subsidence

Project construction will have no subsidence impact because the project does not involve the withdrawal of subsurface fluids that can cause subsidence, nor will it impact sedimentary materials that are particularly prone to subsidence.

8.4.2.2 Soils

Construction will occur in relatively flat terrain and will involve minimal grading. Surface disturbance will be minimized to the extent consistent with safe and efficient completion of the project scope of work. Erosion control best management practices (BMPs) will be used where grading occurs. Topsoil will be salvaged from areas where grading would otherwise result in loss of topsoil, and the salvaged soil will be used to reclaim areas of temporary construction disturbance. Once temporary surface disturbances are complete, areas that will not be subject to additional disturbance will be stabilized by landscaping or, as in the case with agricultural lands owned by others, returned to agricultural land use. Engineering-level geotechnical studies will be completed to assure that the project design adequately accounts for site-specific soil conditions. Considering these factors, the following soil impacts were evaluated for construction impacts.

8.4.2.2.1 Substantial Soil Erosion or Loss of Topsoil

Considering that there will be minimal soil disturbance and grading, and that topsoil will be salvaged and used for reclaiming areas of temporary disturbance, the loss of topsoil will be negligible. As described in Section 8.3 Existing Conditions, the substation site and access road occur in an area where runoff is slow, and the hazard of soil erosion is none to slight where the soil is disturbed. Based on these considerations, any impacts of soil erosion or loss of topsoil would be less than significant.

8.4.2.2.2 Expansive Soils

Based on Soil Conservation Service mapping in the project area, the soils at the substation site, access road, and interconnection route are expansive. Design-level geotechnical studies will evaluate the site-specific soil conditions and the expansive soil condition will be accounted for in the design of these facilities, thereby reducing any impacts to less than significant.

8.4.2.3 Mineral Resources

There are no known important mineral resources that would be impacted by the project. There are no MRZ-2 zones in the project vicinity. Therefore, the project will have no impacts on mineral resources.

8.4.2.4 Paleontology

Construction will occur in relatively flat terrain, which is underlain by the Holocene alluvial sediments, and will involve minimal grading and excavation. Surface disturbance will be minimized to the extent consistent with safe and efficient completion of the project scope of work. In addition, excavation is planned for the two tower locations south of the site.

Impacts to paleontological resources are rated in this report from moderate to low depending on the resource sensitivity of impacted formations. The specific criteria applied for the paleontology sensitivity analysis are summarized below.

- **High sensitivity:** High sensitivity is assigned to geologic formations known to contain paleontological localities with rare, well-preserved, critical fossil materials for stratigraphic or paleoenvironmental interpretation, and fossils providing important information about the paleobiology and evolutionary history (phylogeny) of animal and plant groups. Generally, highly sensitive formations produce vertebrate fossil remains or are considered to have the potential to produce such remains.

- **Moderate sensitivity:** Moderate sensitivity is assigned to geologic formations known to contain paleontological localities with poorly preserved, common elsewhere, or stratigraphically unimportant fossil material. The moderate sensitivity category is also applied to geologic formations that are judged to have a strong but unproven potential for producing important fossil remains.

- **Low sensitivity:** Low sensitivity is assigned to geologic formations that, based on their relatively youthful age and/or high-energy depositional history, are judged unlikely to produce important fossil remains. Typically, low-sensitivity formations produce poorly preserved invertebrate fossil remains in low abundance.

There are no geologic formations at this site that are anticipated to be at the high sensitivity level. The predominant formation expected to be graded and excavated at the substation site, the Holocene alluvial sediments, are classified as low sensitivity and of low significance. There is some potential for excavation in the southern portion of the site to intersect Pleistocene and/or Eocene sediments that would be classified as having moderate sensitivity in this location. Due to the minimal amount of disturbance, the low likelihood of intersecting fossiliferous beds, and the lack of significant fossil discoveries in this vicinity, any impacts on paleontology would be less than significant.

8.4.3 Operations and Maintenance

8.4.3.1 Geology

Operation and maintenance of the project will not have geologic hazard-related impacts.

8.4.3.2 Soils

Operation and maintenance of the project will not have an impact to soils except for occasional surface disturbances that may be required along the transmission interconnection and occasionally for inspections and maintenance. These disturbances will have a negligible impact on soils and will be less than significant.

8.4.3.3 Mineral Resources

There will be no operations and maintenance impacts to mineral resources.

8.4.3.4 Paleontology

There will be no operations and maintenance impacts to paleontological resources.

8.5 MITIGATION MEASURES

Based on the analysis of impacts and the design features that have been incorporated into the project, the project will not have significant impacts related to geology, soils, mineral resources, or paleontology. Therefore, no mitigation measures are required. However, the following standard business practices will be implemented to further minimize any potential impacts:

- Surface disturbance will be minimized to the extent consistent with safe and efficient completion of the project scope of work.
- Topsoil will be salvaged from areas where grading would otherwise result in loss of topsoil, and the salvaged soil will be used to reclaim areas of temporary construction disturbance. Once temporary surface disturbances are complete, areas that will not be subject to additional disturbance will be stabilized by landscaping. Cultivated areas will be tilled for seedbed preparation.
- Erosion control BMPs will be used where grading occurs.

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