

3.6 Geology and Soils

Table 3.6-1 Geology and Soils Checklist

Would the project:	Potentially Significant Impact	Less Than Significant with Mitigation Incorporation	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:	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
ii) Strong seismic ground shaking?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
iii) Seismic-related ground failure, including liquefaction?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
iv) Landslides?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
b. Result in substantial soil erosion or the loss of topsoil?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
c. Be located on a geologic unit 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?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
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?	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
e. Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

3.6.1 Setting

Structurally, the Central Valley Physiographic Province is a large, elongated, northwest-trending asymmetric structural trough that has been filled with an extremely thick sequence of sediments ranging in age from Jurassic to Holocene. This asymmetric geosyncline has a long, stable eastern shelf supported by the subsurface continuation of the granitic Sierran slope and a short western flank expressed by the upturned edges of the basin sediments (Hackel 1966). The project route has been mapped by a number of geologists at a regional scale (Helley and Harwood 1985; Jennings 1977; Saucedo and Wagner 1992; and Wagner et al. 1987). In addition, compilation maps prepared by Jennings (1977); Saucedo and Wagner (1992); and Wagner et al. (1987) reflect mapping work by previous authors. The project route would cross a number of Quaternary-age geologic units as indicated in Figure 3.6-1 and described in Table 3.6-2.

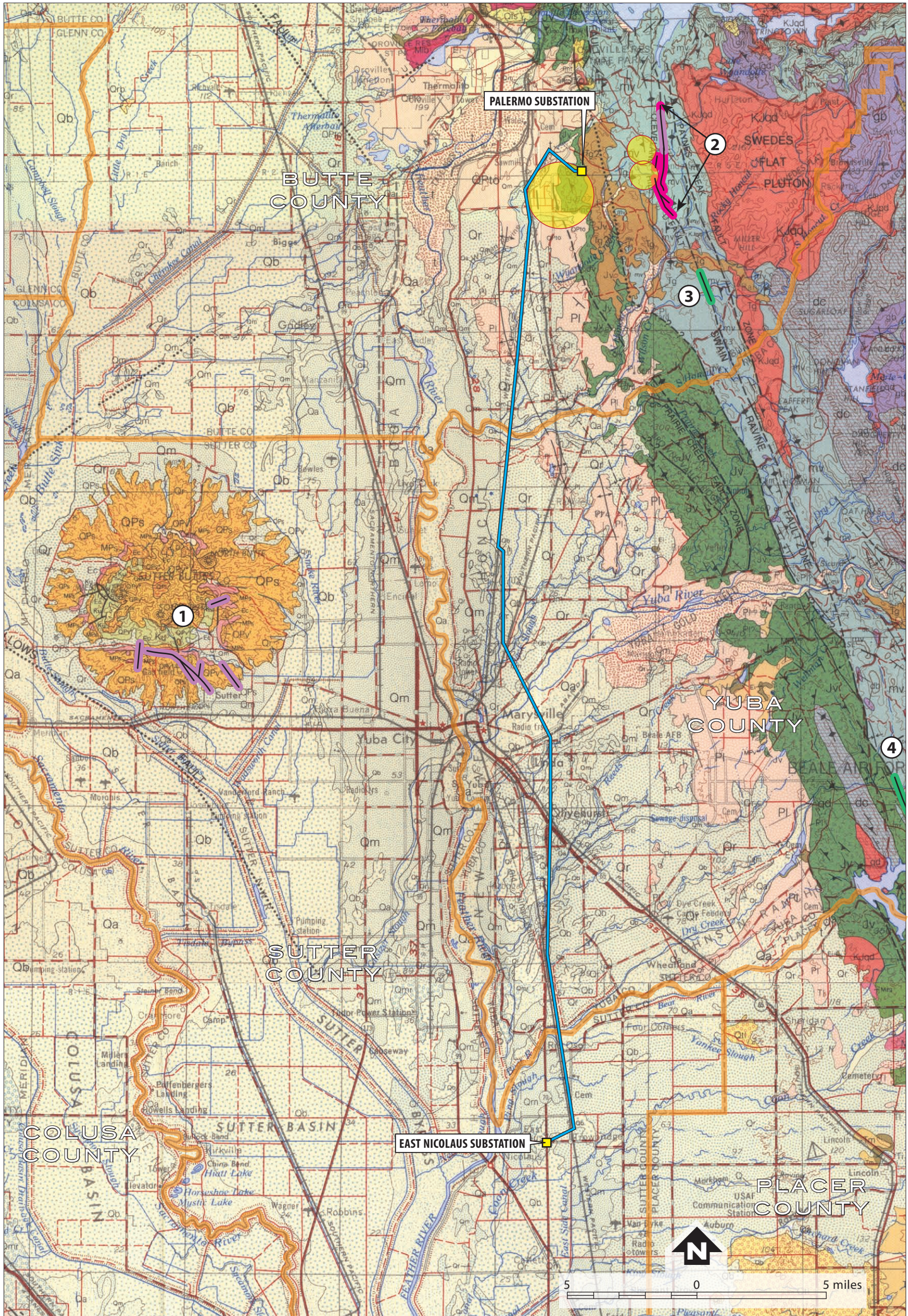
Table 3.6-2 Geologic Map Units Exposed Along the Project Route

Geologic Unit Map Symbol	Geologic Unit Name	Description
Qsc	Stream Channel Deposits	Deposits of open, active stream and river channels without permanent vegetation. These deposits are being transported under modern hydrologic conditions.
t	Tailings	Tailings deposits are derived from dredge gold and gravel mining operations and consist of well sorted, unconsolidated silt, sand, gravel, and cobble, with lesser amounts of clay.
Qa	Alluvium	Alluvium is mapped adjacent to active river or tributary channels and consists of Holocene age, high-energy fluvial deposits (i.e., sand and gravels) and overbank and fan deposits (i.e., sand, silt, and clay). These deposits are unconsolidated.
Qb	Basin Deposits	Helley and Harwood (1985) differentiate basin deposits from alluvium (Qa) on the basis of composition including only those deposits that are finer grained and frequently organic rich and suggest these deposits were distal deposits where energy conditions were much lower.
Qmu / Qml	Modesto Formation	A significant portion of the project route is mapped as being underlain by the Modesto Formation. The Modesto Formation is Upper Pleistocene in age and consists of unconsolidated to moderately cemented gravel, sand, silt, and clay. Dense clay has been encountered (typically in the upper five feet) in this formation (Kleinfelder 2008). The Modesto Formation commonly forms distinct alluvial terraces and fans and is divided into upper (Qmu) and lower (Qml) members.
Qru / Qrl	Riverbank Formation	Similar to the Modesto Formation, the Riverbank Formation is mapped under a significant portion of the project route. The Riverbank Formation generally consists of compact to semi-consolidated, dark brown to red gravel, sand, and silt with some clay. The Riverbank Formation has been dated between 130,000 and 450,000 years before present (BP).
Tla	Laguna Formation	The Laguna Formation is mapped at the northern end of the project route. This Pliocene-age formation is the oldest of the geologic units mapped at the surface along the project route. The Laguna Formation consists of moderately to strongly cemented, interbedded alluvial gravel, sand, and silt. These soils were deposited by the ancestral Feather, Yuba, Bear, and American Rivers (Shlemon 1972).
NA	Buried Stream Channel Deposits	In addition to the geologic units mapped by Helley and Harwood (1985), historical surveys, geologic, and soils maps of the project route show numerous stream channels crossing the project route that have since been buried and/or modified (Kleinfelder 2008).

Source: Kleinfelder 2008

Faulting and Seismicity

The project would be located in a seismically active area given the proximity and number of potential seismic sources. A regional fault and epicenter map showing the approximate location of the project relative to seismic sources and past earthquakes is provided also in Figure 3.6-1.



Project location (transmission line and substation locations)

Displacement during historic time
 Faults showing evidence of displacement during late Quaternary time
 Quaternary (undifferentiated) faults. Classification based on apparent offset of Plio-Pleistocene volcanic rocks

- ① Unnamed faults at Sutter Buttes, Quaternary (undifferentiated)
- ② Cleveland Hill fault, Historic (1975 - 1976)
- ③ Swain Ravine fault zone, Late Quaternary (active in last 100,000 years)
- ④ Spenceville fault zone, Late Quaternary (possibly Holocene; active between 9,000 - 130,000 y.b.p.)

6.1m
Aug. 1, 1975
 5.0-5.4m
(approx. mag)
betw. 1932 - 1999

PALERMO-EAST NICOLAUS 115 KV TRANSMISSION LINE

Figure 3.6-1
Geologic Map of the Regional Area
 (see following page for legend)

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CENOZOIC

QUATERNARY

Holocene

- af Artificial fill
- t Dredge or mine tailings
- Q Alluvium
- Qa Natural levee and channel deposits
- Qb Basin deposits (alluvium)
- Qls Landslide deposits
- Ql Lake deposits
- Qf Fan deposits
- Qt Terrace deposits
- Qg Glacial deposits

Pleistocene

- Qm Modesto Formation (alluvium)
- Qr Riverbank Formation (alluvium)
- Qos Pleistocene nonmarine sedimentary rocks (fluvial and lacustrine gravel, sand, silt, and clay)
- Qrb Red Bluff Formation (coarse red gravel, sand, and silt)
- QPs, QPI Volcanic sediments of Sutter Buttes (volcaniclastic sediments and lahars) QPI - Volcanic lake beds
- QPto, Pnt Tuffs of Oroville (volcaniclastic sediments, and tuff) Pnt-Nomlaki Tuff

Pliocene

- Pt, Pnt Tuscan Formation (Lahars, volcaniclastic sediments, and tuff) Pnt-Nomlaki Tuff
- Pl Laguna Formation (alluvial gravel, sand, and silt)
- Ps Pliocene nonmarine sedimentary rocks (fluvial and lacustrine shale, sandstone, and ash)

Miocene

- MPc Miocene-Pliocene channel deposits (fluvial conglomerates and sandstone)
- MPs Sutter Formation (volcaniclastic sediments; nonmarine)

Oligocene

- Ec Capay Formation (sandstone and shale; marine)
- Ei Ione Formation (quartzose sandstone, claystone, and conglomerate; mostly nonmarine)
- Tg "Auriferous" Gravels

Eocene

- Ku Upper Cretaceous rocks (shale and sandstone; marine)
- Kc Chico Formation (sandstone, conglomerate, and siltstone; marine)

TERTIARY

CRETACEOUS

PALERMO-EAST NICOLAUS 115 KV TRANSMISSION LINE

Figure 3.6-1

Map Legend for the Geologic Map of the Regional Area

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Reference: 1:250,000 Geological Maps of the Chico (1992) and Sacramento (1987) Quadrangles, California Dept. of Conservation - Division of Mines and Geology

- Qv Pleistocene volcanic rocks (b - basalt; bp - scoria and basalt)
- QPv^a Volcanic rocks of Sutter Buttes (QPv^a - andesite; bp - QPv^f - rhyolite)
- Pi Pliocene intrusive rocks (a - andesite; b - basalt)
- Pv Pliocene volcanic rocks (a - andesite; b - basalt)
- MPi Miocene-Pliocene intrusive rocks (a - andesite; b - basalt)
- MPv Miocene-Pliocene volcanic rocks (b - basalt; a - andesite; af - andesite flows; ap - andesite pyroclastic rocks; t - dacitic tuff-breccia)
- Mib Lovejoy Basalt
- ΦMv Oligocene-Miocene volcanic rocks (r - rhyolite tuff and sedimentary rocks)

MESOZOIC PLUTONIC ROCKS

- KJgr Granite, granodiorite
- KJqd Quartz diorite, tonalite, trondhemite, quartz monzonite
- KJdi Diorite
- KJgb Gabbro
- Jgr Granite, granodiorite
- Jqd Quartz diorite, trondhemite
- Jdi Diorite
- Jgb Gabbro
- Jum Ultramafic rocks

MESOZOIC

CRETACEOUS

JURASSIC

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Active faults closest to the project route are the Dunnigan Hills Fault about 19 miles to the west and the Cleveland Hill Fault¹ (western splay of the Foothills Fault System) as close as 2.5 miles east of the project route (Hart and Bryant 1997; International Conference of Building Officials 1997); Jennings 1994). These faults are in Alquist-Priolo Earthquake Fault Zones (Hart and Bryant 1997). According to the California Geological Survey (CGS), the only historic earthquake to have generated surface fault rupture in the Sacramento Valley region occurred on the Cleveland Hill fault (CGS 2007). In 1975, ground rupture was observed and mapped at the ground surface following a magnitude (M) 5.7 Oroville earthquake, primarily along the northern extent of this fault. This rupture was studied by the CGS and placed within an Alquist-Priolo Earthquake Fault Zone; it is still considered capable of ground-surface rupture.

The closest potentially active fault to the project route is the Willows Fault Zone, located less than two miles from the southern end of the project route. This fault zone is mapped as a pre-Quaternary fault zone. However, according to Kleinfelder (2008), the Willows Fault Zone is defined as potentially capable of generating infrequent and moderate-magnitude earthquakes along its northern extent, north of the Sutter Buttes, and is mapped on the basis of offset, deep bedrock strata (i.e., 1,500 feet), and associated groundwater elevation anomalies in that region. The Willows Fault was originally mapped by Harwood and Helley (1987) and subsequently by others as a steeply dipping reverse fault, and is considered to be active. Kleinfelder (2001) indicated that a M6.6–6.7 was appropriate for the Willows Fault, although there is some speculation as to whether or not the fault is currently active.

Seismic hazards associated with seismically active areas include earthquake fault ground rupture and ground shaking (primary hazards), liquefaction, and earthquake-induced slope failure (secondary hazards). The project route would be located within an area influenced by several major faults to the east and west.

Fault Rupture. No known active fault or potentially active fault crosses the project route, and there is no evidence of recent (Holocene) faulting within the project route vicinity (Kleinfelder 2008). Furthermore, review of aerial photographs does not indicate the presence of lineations or other features that would suggest the presence of recent faulting on or trending towards the project route (Kleinfelder 2008).

Ground Motion. The project route would be subject to seismic hazards because of its proximity to active faults, fault systems, and fault complexes. Some of the officially recognized active faults (e.g., recognized by the State of California or Uniform Building Code [UBC]) are located within a 20-mile radius of the project area. The project route would be located in a region of California characterized by a low ground-shaking hazard. Based on a probabilistic seismic hazard map that depicts the peak horizontal ground acceleration values exceeded at a 10 percent probability in 50 years (Cao et al. 2003, California Geological Survey 2006), the probabilistic peak horizontal ground acceleration values in the project area range from 0.1 to 0.2g, where one “g” equals the force of gravity, indicating that the ground-shaking hazard in the project area is low to moderate. Farther to the east and west, the ground-shaking hazard increases more, coinciding with the increase in abundance of associated faults and fault complexes (Cao et al. 2003, CGS 2006).

¹ This fault was responsible for the 1975 M5.7 Oroville earthquake, an event that produced surface displacement along about 2.2 miles of the fault. Ground motions corresponding to Modified Mercalli Intensity VIII were experienced at Gridley and Oroville. Significant structural damage occurred to unreinforced masonry buildings in Oroville. Geologic studies indicate that the total length of the Cleveland Hills fault is probably 11 to 15 miles. The maximum credible earthquake on this fault is probably about M6.5–6.7. An event of this magnitude would cause substantially more damage than the 1975 event (Butte County 2005).

Soils

The soils along the project route have been mapped by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) and are described in the Soil Survey of the Butte Area; Parts of Butte and Plumas Counties (Burkett and Conlin 2006); the Soil Survey of Sutter County (Lytle 1988); and the Soil Survey of Yuba County (Lytle 1998). Table 3.6-3 describes the general soil map units occurring from north to south along the project route (Burkett and Conlin 2006; Lytle 1998; Lytle 1988).

Table 3.6-3 Soil Map Units along the Project Route

General Soil Map Unit	Soil Unit Description
Dunstone-Loafercreek-Argonaut Taxadjunct	Shallow and moderately deep, nearly level to moderately steep, well-drained soils that formed in residuum and colluvium; on foothills.
Thompsonflat-Oroville-Vistarobles	Very deep, moderately deep, and shallow, nearly level to moderately steep, moderately well-drained and poorly drained soils that formed in alluvium; on intermediate and high fan terraces. Limited by slow permeability and a hazard of ponding in some areas.
Eastbiggs-Duric Xerarents-Kimball	Moderately deep, shallow, and very deep, nearly level, somewhat poorly drained and well-drained soils that formed in alluvium; on low terraces. Limited by slow permeability and a hazard of ponding in some areas.
Conejo-Kilaga	Very deep or deep, well-drained alluvial soils; on stream terraces. Few limitations except for slow permeability and a hazard of flooding in some areas.
San Joaquin	Moderately well-drained alluvial soils that are moderately deep to a hardpan and have a dense clay subsoil; on low fan terraces. Limited by very slow permeability.
Columbia-Holillipah-Shanghai	Very deep, somewhat poorly drained or somewhat excessively drained, alluvial soils; on floodplains. Limited by a hazard of flooding in some areas.
Shanghai-Nueva-Columbia	Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam; on floodplains. Limited by a hazard of flooding and a high water table in some areas.
Conejo-Tisdale	Moderately deep to very deep, level to nearly level, well drained loam and clay loam; on terraces. Limited by a restricted soil depth.
San Joaquin-Cometa	Moderately deep and very deep, level to nearly level, well drained sandy loam and loam; on terraces. Limited by very low to moderate water capacity and very slow permeability.
Clear Lake-Capay	Deep and very deep, level to nearly level, poorly drained and moderately well drained clay and silty clay; in basins and on basin rims. Limited by slow permeability.

Sources: Burkett and Conlin 2006; Lytle 1998; Lytle 1988

Geologic Hazards

Liquefaction. Liquefaction occurs primarily in saturated, loose, fine-to-medium grained soils in areas where the groundwater table is within approximately 50 feet of the ground surface. Shaking causes the soils to lose strength and behave as a liquid. Geologic mapping by Helley and Harwood (1985) shows significant portions of the project route to be underlain by basin and Holocene-age alluvial deposits. These units generally consist of unconsolidated gravel, sand, silt, and clay. Depending on groundwater levels² and the intensity of a seismic event, these units have the potential to liquefy during a seismic event.

In Butte County, areas paralleling the Sacramento River that contain clean sand layers with low relative densities are estimated to have generally high liquefaction potential. Granular layers underlying most of the remaining Sacramento Valley area of Butte County have higher relative densities and thus have

² Groundwater is anticipated within the proposed depths of exploration for the portion of the route located within the valley sediments a few miles south of Palermo. Groundwater levels are expected to range from near the ground surface to depths of more than 20 feet below ground surface for this portion of the project route. Groundwater is not anticipated within the depths of exploration for the higher elevation sites near Palermo (Kleinfelder 2008).

moderate liquefaction potential. Clean layers of granular materials older than Holocene are of higher relative densities and are thus of low liquefaction potential. The project route would generally traverse areas of moderate liquefaction potential (Butte County 2005, Figure 16-4).

In Yuba and Sutter counties, areas with a high liquefaction potential are similar to those areas described for Butte County (Sutter County 1996; Yuba County 2008). Areas paralleling the Sacramento, Feather, and Bear Rivers that contain clean sand layers with low relative densities coinciding with a relatively high water table are estimated to have generally high liquefaction potential. Granular layers underlying certain areas in the Sacramento Valley have higher relative densities and thus have moderate liquefaction potential.

Landslides. Landslides, rock falls, and debris flows occur continuously on all slopes; some processes act very slowly, while others occur very suddenly, with potentially disastrous results. Based on an analysis of aerial photographs, no landslides were observed along the project route (Kleinfelder 2008), and no geomorphic features indicative of landsliding were observed (e.g., scarps, hummocky topography, etc.). However, the project route does cross several major rivers and/or drainages with embankments. The stability of major river levee embankments is the purview of the United States Army Corps of Engineers. The stability of other embankments and/or creek banks that could affect the proposed pole foundations would need to be assessed during preparation of the project geotechnical report(s).

Soil Erosion. Areas of differing erosion hazard potential for Butte County are delineated (Butte County 2005, Figure 16-5). The areas with the greatest erosion hazard potential generally occur in the foothills of Butte County, whereas the project route would generally traverse areas of moderate and slight erosion hazard potential. Moderate erosion hazard potential is defined as occurring on areas with slopes of 9 to 30 percent with soils of no profile development to weak profile development and slopes of 9 to 15 percent with moderate profile development. Slight erosion hazard potential is defined as occurring on areas with slopes of two to nine percent with permeability at least moderate with weak soil profile development (Butte County 2005).

Areas of differing erosion hazard potential for Yuba County are delineated (Yuba County 2008, Exhibit GS-2). The areas with the greatest erosion hazard potential generally occur in the foothills and mountain areas in the central and eastern part of the county, whereas the project route would traverse areas of slight erosion hazard potential. Slight erosion hazard potential is defined as erosion unlikely to occur under ordinary climatic conditions (Yuba County 2008).

For Sutter County, areas with a moderate or high erosion hazard potential are not common, with the exception of moderate to high erosion hazard potential in the Sutter Buttes. The majority of Sutter County exhibits areas of low erosion activity including the areas along the project route.

Collapsible Soils. Differential settlement (also called ground settlement and, in extreme cases, ground collapse) results as soil compacts and consolidates after ground shaking ceases. Differential settlement occurs when the layers that liquefy are not of uniform thickness, a common problem when the liquefaction occurs in artificial fills (ABAG 2001). Settlement can range from one percent to five percent, depending on the cohesiveness of the sediments (Tokimatsu and Seed 1984).

Expansive Soils. Shrink-swell or expansive soil behavior is a condition in which soil reacts to changes in moisture content by expanding or contracting. Soil expansiveness (or shrink-swell potential) is expected to range from none to high along the project route. The distribution of expansive soils within Butte County is delineated (Butte County 2005, Figure 16-8). Soils with no or low expansion potential occur along stream and river valleys and on steep mountain slopes. Soils of high expansion potential occur in

the level areas of the Sacramento Valley, including around the population centers of Chico, Oroville, Biggs, and Gridley. In general, the project route occurs in areas with highly expansive soils (Butte County 2005).

For Yuba County, the distribution of expansive soils is delineated (Yuba County 2008, Exhibit GS-3). Soils having high shrink-swell potential are more common on the western end of the county, where the project route would occur. Some soils with moderate shrink-swell potential are also located in valleys in the easternmost part of the county. In general, the project route would traverse areas with a low to high shrink-swell potential (Yuba County 2008).

The distribution of expansive soils within Sutter County is most likely to occur in basins and on basin rims (Sutter County 1996, Figure 10.3-1). Soils with no or low expansion potential occur along the rivers and river valleys and on steep mountain slopes. The only area along the project route in Sutter County that has a high shrink-swell potential is the Clear Lake-Capay general soil map unit, which is where the southernmost portion of the project route would occur (Sutter County 1996).

Subsidence. Subsidence is the sinking of a large area of ground surface in which the material is displaced vertically downward, with little or no horizontal movement. Subsidence occurs in three ways: as a result of groundwater overdraft or oil and gas withdrawal; compaction and oxidation of peat soils; and hydrocompaction. Land subsidence caused by groundwater overdraft results when groundwater extraction produces compression of a clay bed within an aquifer so much that it no longer expands to its original thickness after groundwater recharge. The pores within the clay bed collapse, and the surrounding clay particles settle in their place. When the clay particles settle, the clay bed is effectively thinned, resulting in permanent land subsidence at the ground surface. Subsidence can also occur from the withdrawal of oil and gas. Land subsidence as a result of compaction and oxidation of peat soils and/or hydrocompaction are not significant concerns in the northern Sacramento Valley.

The damaging effects of subsidence include gradient changes in roads, streams, canals, drains, sewers, and dikes. Many such systems are constructed with slight gradients and may be significantly damaged by even small elevation changes. Other damaging effects include damage to water wells resulting from sediment compaction and increased likelihood of flooding of low lying areas (Butte County 2005). Subsidence is a potential hazard for the portions of Butte County located within the Sacramento Valley. The greatest potential subsidence areas are those where heavy groundwater withdrawal is occurring in gas-producing areas. According to investigations by the U.S. Geological Survey, the areas of heaviest groundwater withdrawal extend about two miles north and south of Chico and in a one-mile radius around Gridley—areas where the project route would traverse. The amount of subsidence that could take place depends primarily on the amount of groundwater withdrawal (Butte County 2005).

No information pertaining to land subsidence in Yuba County is readily available. However, it appears that land subsidence is a potential hazard for the portions of Yuba County located within the Sacramento Valley (Butte County 2005, Figure 16-6).

Sutter County is not subject to high subsidence. Future potential for subsidence in Sutter County could result from prolonged periods of drought and a significant increase in natural gas withdrawal (Sutter County 1996).

Regulatory Setting

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. While this Act does not specifically regulate substations, it does help define areas where fault rupture is most likely to occur by grouping faults into categories of active, potentially active, and inactive.

The Seismic Hazards Mapping Act of 1990 directs the CGS to delineate Seismic Hazard Zones and requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones. It addresses the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes. The Act also addresses tsunamis and seiches.

Applicant Proposed Measures

The applicant has incorporated the following applicant proposed measures (APMs) into the project to minimize or avoid impacts on geology and soils. See Chapter 1.0 for a complete list of APMs that the applicant has incorporated into the project to avoid or minimize impacts on all resources.

APM GEO-1: Incorporate measures identified in geotechnical report/use of standard engineering practices to mitigate for individual site-specific and design-specific hazards.

APM HYDRO-1: Prepare and implement a storm water pollution prevention plan.

3.6.2 Environmental Impacts and Mitigation Measures

- 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.*

LESS THAN SIGNIFICANT. The project does not lie within an Alquist-Priolo Earthquake Fault Zone. The purpose of the Alquist-Priolo Act is to regulate development near active faults to mitigate the hazard of surface rupture. Faults in an Alquist-Priolo Earthquake Fault Zone are typically active faults. The closest mapped fault, the Willows Fault Zone, is not considered an active fault and is not delineated on the most recent Alquist-Priolo Fault Zoning Map (CGS 2007); however, the fault is considered potentially active. Kleinfelder (2001) indicates that a M6.6–6.7 was appropriate for the Willows Fault, although there is some speculation as to whether or not the fault is currently active. Both the Cleveland Hill Fault and the Dunnigan Hills Fault are considered active and capable of producing M6.5–6.7 and M6.6 earthquakes, respectively. Due to the close proximity of the project route to the Cleveland Hill Fault and the Willows Fault Zone, potential impacts from surface fault rupture may be significant. Transmission poles are susceptible to damage or failures if they directly overlie a fault trace that experiences surface rupture. Within the project route, the potential for fault surface rupture is generally concentrated in the vicinity of mapped active and early Quaternary fault traces and within established earthquake fault zones. As demonstrated in other areas of California, surface fault rupture and significant ground distortion may occur within a zone extending several hundred feet on either side of the main fault trace. Therefore, project components that intersect, occupy, or are adjacent to active and early Quaternary fault traces and earthquake fault zones are subject to potentially significant impacts from fault surface rupture. However,

the project does not appear to cross any known fault, and no change to the existing conditions would occur during construction. With implementation of APM GEO-1, impacts caused by the rupture of a known earthquake fault would be less than significant.

ii) Strong seismic ground shaking?

LESS THAN SIGNIFICANT. The project is located in a seismically active area given the proximity and number of potential seismic sources. The closest potentially active fault to the project route is the Willows Fault Zone (less than 2 miles from the southern end of the project route) but is not delineated on the most recent Alquist-Priolo Fault Zoning Map (CGS 2007). Active faults closest to the project route are the Cleveland Hill Fault (2.5 miles east of the project route) and the Dunnigan Hills Fault (about 19 miles to the west). These faults are in Alquist-Priolo Earthquake Fault Zones. Based on the number and proximity of two known active faults (Figure 3.6-1), there is the potential for an earthquake to occur during the life of the project.

A large earthquake on any of the nearby faults could cause strong ground shaking along the project route, with the potential to damage associated project structures. The greatest potential for strong seismic ground shaking along the project route comes from the active Cleveland Hill Fault, which has produced moderately large earthquakes in the past. In addition to the Cleveland Hill Fault, other active or early-Quaternary faults in the vicinity of the project also present the potential for strong ground shaking.

Overhead transmission lines, however, can accommodate strong ground shaking. Wind-loading design requirements for overhead lines are generally more stringent than those developed to address strong seismic ground shaking. With implementation of APM GEO-1, impacts from strong seismic shaking would be less than significant.

iii) Seismic-related ground failure, including liquefaction?

LESS THAN SIGNIFICANT. Severe ground shaking can trigger landslides, cause fissures and cracks to open in the ground, and cause loose, saturated materials to liquefy. Liquefaction susceptibility reflects the relative resistance of soils to loss of strength when subjected to ground shaking, and occurs primarily in saturated, loose, fine-to-medium grained soils in areas where the groundwater table is within approximately 50 feet of the ground surface. Shaking causes the soils to lose strength and behave as a liquid. The potential for liquefaction along the project route is moderate. Seismic-induced ground failure has the potential to distress, displace, and/or destroy project components. However, no change to the existing conditions would occur during construction. Use of site-specific seismic data for project design obtained through geotechnical investigation would reduce potential impacts of liquefaction and other types of seismic ground failure. Therefore, with implementation of APM GEO-1, impacts caused by strong seismic shaking would be less than significant.

iv) Landslides?

LESS THAN SIGNIFICANT. Landslides can occur as shallow slides of unconsolidated material as well as deep-seated slides in bedrock. Events that trigger landslides include seismic ground shaking, over-weighting the slope with either naturally-deposited colluviums or artificial fill, decreasing soil cohesiveness by adding water to the materials on the slope, or undercutting a slope through erosive action or man-made disturbance. Based on an analysis of aerial photographs, no landslides were observed along the project route (Kleinfelder 2008), and no geomorphic features indicative of landsliding were observed (e.g., scarps, hummocky topography, etc.). However, the project route does cross several major rivers and/or drainages with embankments. The stability of major river levee embankments is the purview of the United States Army Corps of Engineers. The stability of other embankments and/or creek banks that

could affect the proposed pole foundations would need to be assessed during preparation of the project geotechnical report(s). No change to the existing soil stability conditions, including potential for landslides, due to implementation of the project would occur during construction. With implementation of APM GEO-1, impacts caused by landslides would be less than significant.

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

LESS THAN SIGNIFICANT. Grading, excavation, removal of vegetation cover, and loading activities associated with construction activities could temporarily increase erosion, runoff, and sedimentation. Construction activities could also result in soil compaction and wind erosion effects that could adversely affect soils and reduce the re-vegetation potential at the construction sites and staging areas. A Storm Water Pollution Prevention Plan (SWPPP) would be developed by a qualified engineer or erosion control specialist and implemented before construction (APM HYRDO-1). The SWPPP would include details of how the sediment and erosion control BMPs would be implemented. Implementation of the SWPPP would comply with state and federal water quality regulations. In addition, relevant recommendations from the required site-specific, design-level geotechnical investigations required under APM GEO-1 would also minimize negative effects associated with erosion, runoff, and sedimentation. As a result, erosion impacts would be less than significant.

c. Would the project be located on a geologic unit 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. The project would be located on near-surface materials that include residual silt and clay soils overlying volcanic sediments and/or tuffs in Oroville, and/or interbedded clays, silts, sands, and gravels of the Tertiary Laguna Formation on the northern end of the project route. The remainder of the project route to the south would traverse older Quaternary alluvium including interbedded clays, silts, sands, and gravels of the Modesto and Riverbank Formations, and younger Quaternary silt, sand, and gravel river channel and overbank deposits, and organic rich, lean to dense clay basin deposits. Soft and/or loose soils would be generally expected to occur in various areas along the project route. Along the project route, differential settlement would be expected to be a concern.

Destabilization of natural or constructed slopes could occur as a result of construction activities. Excavation, grading, and fill operations associated with providing access to tower locations and other project components could alter existing slope profiles making them unstable as a result of over-excavation of slope material, steepening of the slope, or increased loading. Temporary construction slopes and existing natural or constructed slopes impacted by construction operations would be evaluated for stability. Construction activities likely to result in slope or excavation instability would be suspended during and immediately following periods of heavy precipitation when slopes are more susceptible to failure. For construction requiring excavations, such as foundations, appropriate support and protection measures would be implemented to maintain the stability of excavations and to protect surrounding structures and utilities.

With implementation of APM GEO-1, design-level geotechnical investigations would be performed where necessary to evaluate subsurface conditions, identify potential hazards, and provide information for development of excavation plans and procedures. Appropriate design features and construction procedures would be implemented to maintain stable slopes and excavations during construction. Therefore, impacts from slope or excavation instability would be less than significant.

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?

LESS THAN SIGNIFICANT. Soil expansiveness (or shrink-swell potential) is expected to range from none to high along the project route. Many of the natural soil types identified along the project route have high clay contents and thus potentially have moderate to high shrink-swell potential. Site-specific soil expansiveness analyses should be performed where these deposits are mapped and/or encountered during the subsurface investigation(s). Expansive soils may cause differential and cyclical foundation movements that could cause damage and/or distress to overlying structures and equipment. Potential operation impacts from loose sands, soft clays, and other potentially compressible soils include excessive settlement, low foundation-bearing capacity, and limitation of year-round access to project facilities. However, design-level geotechnical studies would be conducted to develop appropriate design features for locations where potential problems are known to exist (APM GEO-1). Appropriate design features may include excavation of potentially problematic soils during construction and replacement with engineered backfill, ground treatment processes, direction of surface water and drainage away from foundation soils, and the use of deep foundations such as piers or piles. No change to the existing soil stability conditions, including expansive soil, due to implementation of the project would occur during construction and operation. With implementation of APM GEO-1, impacts would be less than significant.

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

NO IMPACT. The project would not involve the construction of septic tanks, the use of existing septic tanks, or an alternative wastewater disposal system during construction or operation. Therefore, there would be no impact under this criterion.

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