C.5 Geology, Soils, and Paleontology

This section addresses the environmental setting and impacts related to the construction and operation of the proposed Project and alternatives involving the issues of geologic and seismic hazards, and paleontology. The primary reason to define geologic and seismic hazards is to protect structures from physical damage and to minimize injury/death of people due to structure damage or collapse. Section C.5.1 provides a summary of existing geological, soil, and paleontological conditions present along the alignment of SCE's Antelope-Pardee 500-kV Transmission Project and associated geologic and seismic hazards. Applicable regulations, plans, and standards are listed in Section C.5.2. Potential impacts and mitigation measures for the proposed Project are presented in C.5.5; and alternatives are discussed in Sections C.5.6 through C.5.11.

C.5.1 Affected Environment

Baseline geologic, seismic, soils, and paleontological information were collected from published and unpublished literature, GIS data, and online sources for the proposed Project and the surrounding area. The literature and data review was supplemented by a brief field reconnaissance of the proposed alignment. The literature review and field reconnaissance focused on the identification of specific geologic hazards and paleontologic resources.

C.5.1.1 Physiography

The Antelope-Pardee 500-kV Transmission Project is located within the Transverse Ranges geomorphic province of southern California, which is characterized by a complex series of mountain ranges and valleys with dominant east-west trends. The Antelope-Pardee Project traverses four distinct geographic areas, the Antelope Valley, the Leona Valley (the San Andreas Rift Zone), the Liebre-Sierra Pelona Mountains, and the Santa Clarita Valley. The Antelope Valley consists of approximately 1200 square miles of elevated desert terrain, located along the western edge of the Mojave Desert. The Leona Valley is a small, northwest-southeast trending longitudinal valley formed by movement on multiple overlapping strands of the San Andreas Fault in the San Andreas Rift Zone, and in the Project area is bounded on the northeast by the Portal Hills and on the southwest by foothills of the Sierra Pelona. The Liebre-Sierra Pelona Mountains are a small northwest-southeast trending mountain range within the central Transverse Ranges. The Santa Clarita Valley is primarily formed by the convergence of the Santa Clara River with several large unnamed streams that flow from the north from Castaic Valley and, San Francisquito, Dry, and Bouquet Canyons. Additionally, lateral fault movement of the San Gabriel Fault has caused the Santa Clarita Valley to be offset and widened in the Project area.

Elevations along the proposed alignment range from about 1060 feet at the Pardee Substation to approximately 4,200 feet above mean sea level (msl) in the Liebre-Sierra Pelona Mountains near where the alignment crosses the Grass Mountain Leona Divide Road. The Antelope Substation is located at an elevation approximately 2470 feet above msl. Elevations were determined using USGS 7½ minute quadrangles from 3-D TopoQuads software (Delorme, 1999).

C.5.1.2 Geologic Conditions and Hazards

Geologic Setting

The Antelope-Pardee transmission line would cross four areas of distinctive geologic character and province, the Antelope Valley, the San Andreas Rift Zone, the Liebre-Sierra Pelona Mountains, and the Soledad Basin. The regional geology of the Project area is depicted on Figure C.5-1.

Antelope Valley. The Antelope Valley is primarily an alluviated desert plain containing bedrock hills and low mountains. The rocks of the western Antelope Valley are characterized by relatively flat-lying topography and valley fill deposits. In the Project area and vicinity, the western Antelope Valley is covered primarily by alluvial deposits of Quaternary age: Holocene Alluvium and Pleistocene Older Alluvium. The Holocene alluvial deposits consist of slightly dissected alluvial fan deposits of gravel, sand and clay. The Older Alluvium is located primarily near the margins of the Antelope Valley at the flanks of Portal Ridge and consists of weakly consolidated, uplifted and moderately to severely dissected alluvial fan and terrace deposits composed primarily of sand and gravel (Dibblee, 2002). The ridges are comprised of crystalline rocks of igneous and metamorphic composition. The west-trending Hitchbrook Fault, which diverges from the San Andreas Fault northwest of the Project area, separates Portal Ridge, with Pelona Schist on the southeast from granitic rocks on the northwest. Beyond the ridge, the Project alignment crosses into the San Andreas rift zone in Leona Valley.

San Andreas Rift Zone. In the Project area, the San Andreas Fault lies within a linear, trough-like valley called the San Andreas Rift Zone. The Rift Zone in the Project area consists of several anastomosing fault segments (i.e. interlacing faults), which along with the presence of Amargosa Creek, has widened the zone into a valley, the Leona Valley. Holocene Alluvium, Pleistocene Older Alluvium, and the non-marine Pliocene Anaverde Formation underlie the Lenore Valley. Exposed among interlacing fault strands within the San Andreas Fault Zone are several members of the Anaverde Formation: the sandstone, clay shale, and breccia members (CGS, 2006; Dibblee, 2002). The sandstone member is a medium-to thick-bedded, locally massive, fine to coarse-grained, locally pebbly, with local thin silty interbeds. The clay shale member is a thin-bedded, sandy, silty, locally very gypsiferous clay shale with interbedded siltstone and sandstone layers. The breccia member is a distinctive, reddish to dark gray, massive, pervasively sheared sedimentary breccia with angular clasts of hornblende diorite. The bedding within the Anaverde Formation members mostly parallel the bounding faults, and has steep to vertical dips (CGS, 2006).

Liebre-Sierra Pelona Mountains. The Liebre-Sierra Pelona Mountains are composed of late Mesozoic or older granitic and metamorphic rocks north of the Clearwater Fault, Paleocene (early Tertiary) San Francisquito Formation between the Clearwater and San Francisquito Faults, and Mesozoic or older Pelona Schist south of the San Francisquito Fault. The granitic and metamorphic rocks consist of a complex mixture of biotite rich, closely fractured quartz diorite and gneiss with local inclusions of diorite and amphibolite. San Francisquito Formation is a layered marine clastic, lithified sedimentary rock formation comprised of thick-bedded arkosic sandstone, cobble and pebble conglomerate, and clay shale and siltstone. The Pelona Schist is primarily composed of distinctive bluish gray schist that was metamorphosed from clastic and pryoclastic sedimentary rocks.

Soledad Basin. The Soledad depositional basin is juxtaposed against the Ventura depositional along the San Gabriel Fault, a major structural boundary feature. Rocks that accumulated in the Soledad Basin are exposed northeast of the fault. Geologic units exposed within Project area consist of upper Miocene Mint Canyon Formation, upper Miocene Castaic Formation, Plio-Pleistocene Saugus Formation, Pleistocene Older Alluvium, and Holocene Alluvium. The nonmarine Mint Canyon Formation consists of well-bedded interlayered conglomeratic sandstone, claystone, and siltstone of fluvial and lacustrine origin. Overlying the Mint Canyon Formation is the Castaic Formation which consists of shallow marine sandstone and shale, distinguishable by the large variety of mollusk species from the upper Miocene. The Saugus Formation, which is the dominant rock unit exposed in the area is composed of interbedded nonmarine sandstone, siltstone, and pebble-cobble conglomerate. The Older Alluvium consists of subunits of older alluvial fans and older terrace deposits of poorly consolidated interbeds of sand, silt, and gravel. Alluvium covers the floor and margins of the valley formed by the Santa Clara River and extend up into the canyons in the surrounding hills and mountains. The Alluvium consists of slope wash, landslide deposits, and younger alluvium. Modern man-made fill is also mapped in some areas.

Project Geologic Conditions. Geologic conditions likely to be encountered during construction of the proposed Antelope-Pardee 500-kV Transmission Project are summarized in Table C.5-1. The table includes: name of the geologic formation or feature; the geologic age of the formation or feature, a description and comments about the formation's general rock type, lithology, and susceptibility to specific geologic hazards as appropriate; and general excavation characteristics of the unit related to excavation or drilling of tower and structure foundations. Descriptions of geologic units in the Project area are based on published geologic quadrangle maps by Thomas Dibblee (1996b, c; 1997a, b; 2002).

Table C.5-1. Geology along the Proposed Antelope-Pardee 500-kV Transmission Line Route

Mile Marker[1, 2]	Formation/ Feature Name[1]	Geologic Age of Formation/ Feature	Description/Comments[1]	Excavation Characteristics[3]
Antelope Valley and Foothills				
0 -2.3	Alluvium	Holocene	Antelope Substation at MP 0; Alluvial sand and clay	Easy
2.3 – 2.8	Older Alluvium	Pleistocene	Sand and gravel fan deposits	Easy
2.8 – 3.0	Quartz monzonite	Cretaceous	Granitic rocks, variable weathering profile	Difficult
3.0 – 3.4	Alluvium	Holocene	Identified liquefaction potential	Easy
3.2	Hitchbrook Fault	Holocene	Branch fault of the San Andreas Fault Zone; minor fault rupture hazard, this branch not currently considered active	Not Applicable
3.4-3.8	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist of Portal Ridge, Identified landslide potential	Difficult
San Andreas Rift Zone				
3.8 -4.3	Alluvium	Holocene	Identified liquefaction potential	Easy
4.3-4.7	San Andreas Fault Rift Zone and Anaverde Fm	Recent and Holocene Pliocene	Rift zone of San Andreas Fault; significant fault rupture hazard Anaverde Formation (sandstone, shale, and breccia) and quartz diorite; identified landslide hazard potential	Easy
4.7-5.2	Alluvium	Holocene	Identified liquefaction potential	Easy
5.1	San Andreas Fault	Recent & Holocene	Concealed strand of the San Andreas Fault	Not Applicable
Liebre Mountain - Sierra Pelona Uplift				
5.2-9.4	Quartz diorite	Late Mesozoic and older	Granitic rocks, variable weathering profile, possible landslide hazard potential	Difficult
9.4	Clearwater Fault	Late Quaternary	Potentially active, minor rupture hazard	Not Applicable
9.4-10.5	San Francisquito Fm	Paleocene	Lithified, fractured, marine clastic rocks. Argillaceous shales and sandstones; possible landslide hazard potential	Moderate to Difficult
10.5	San Francisquito Fault	Pre-Quaternary	Likely inactive, no significant fault rupture hazard	Not Applicable

Table C.5-1. Geology along the Proposed Antelope-Pardee 500-kV Transmission Line Route

Mile Marker[1, 2]	Formation/ Feature Name[1]	Geologic Age of Formation/ Feature	Description/Comments[1]	Excavation Characteristics[3]
10.5-12.3.3	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
12.3-12.8	Landslide	Recent	Large feature in foliated metamorphic rock;	Difficult
12.8-13.1	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
13.1-13.8	Landslide	Recent	Large feature in foliated metamorphic rock; landslide hazard potential	Difficult
13.8-17.5	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
Soledad Basin				
17.5-19.8	Mint Canyon Fm	middle Miocene	Moderately indurated terrestrial fluviatile, predominantly sandstone; identified landslide hazard potential; liquefaction potential in alluvial areas	Moderate
19.8-20.5	Castaic Fm	late Miocene	Clastic marine sediments, claystone w/ lesser sandstone; identified landslide hazard potential	Moderate
20.5-20.6	Alluvium	Holocene	Haskell Canyon; identified liquefaction potential	Easy
20.6-22.8	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified landslide hazard potential	Easy to Moderate
22.8-22.9	Alluvium	Holocene	Dry Canyon, identified liquefaction potential	
22.9-23.8	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified landslide hazard potential	Easy to Moderate
23.8-24.1	Alluvium	Holocene	Sand and gravel in San Francisquito Canyon; identified liquefaction potential	Easy
24.1-25.1	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified seismically induced landslide hazard potential	Easy to Moderate
25.1	San Gabriel Fault	Holocene	Active right slip fault; fault rupture hazard	Not Applicable
25.1-25.2	Alluvium	Holocene	Reentrant off Santa Clara River Valley, identified liquefaction potential	Easy
25.2-25.3	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified landslide hazard potential	Easy to Moderate
25.3-25.6	Alluvium	Holocene	Sand and gravel, Santa Clara River Valley; identified liquefaction potential; Pardee Substation at mile 25.6	Easy

Notes: 1) Information in these columns is primarily derived from Table 4.7-1 of the PEA. Project milepost measurements were assumed to be accurate and not remeasured.
2) Refer to Figure C.5-1 (Regional Geologic Map) for approximate mile marker locations, actual mileposts (from PEA) for the alignment measured from geology on Dibblee geologic maps.
3) Excavation characteristics are very generally defined as "easy," "moderate," or "difficult" based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Previous Geotechnical Studies

Reports and memos for various geotechnical investigations that have been conducted at both the Antelope and Pardee Substations were reviewed and are listed below.

Antelope Substation

- Letter Report: Antelope Substation – Pile Design Data; T.M. Leps, Chief Civil Engineer, April 25, 1952
- Memorandum: Antelope Substation, Foundation Investigation; E.E. Chandler, Assistant Civil Engineer, July 19, 1957
- Antelope Substation Boring Logs and Soil Test Results; December 1996

- Letter Report: Foundation Design Recommendations, Antelope Substation Additions, Los Angeles County, California; Engineering and Technical Services Geotechnical Group, January 9, 1997

The reports and data reviewed for the Antelope Substation indicate that the materials underlying the site consist of Recent Alluvium, composed primarily of loose to medium dense silty sand with gravel, with local gravelly, cobbly, and clayey layers. No groundwater was encountered in any of the borings conducted for these investigations; the borings were conducted to a maximum depth of 40 feet.

Pardee Substation

- Report of Geotechnical Investigation, Pardee Substation Site, Near Castaic Junction, California; for Southern California Edison Company; Evans, Goffman & McCormick, May 15, 1970
- Report of Inspection and Testing of Site Grading, Pardee Substation, County of Los Angeles; for Southern California Edison; Evans, Goffman & McCormick, August 26, 1970
- Pardee Substation: Portal Structure Foundation Void Grouting; Edison Geotechnical Group, June 24, 1994

Review of the above listed reports for the Pardee Substation indicate that the site is underlain by Recent to Older Alluvium ranging from relatively firm, dense sand and silty sand in the northeastern portion of the site to very soft clayey to sandy silt in the southern portion of the site. Groundwater is relatively shallow beneath the site and was encountered at depths of 9 to 12 feet below ground surface. During construction of the facility, grading was conducted consisting of excavation and cut of sloping hillside areas at the northeastern portion of the property and fill in the center of the property. Minor cut and fill was also conducted in other areas of the site during grading for facility construction.

The 1994 Northridge Earthquake caused severe groundshaking at the Pardee Substation, resulting in shaking and rocking of the portal towers. This rocking motion resulted in the tower footings moving within the surrounding soil and created voids between the concrete piles and the soil. Pressure grouting was conducted at 22 tower locations to fill the voids in the soil and return the soil to pre-earthquake strength; one tower was replaced due to severe damage to the tower and footing.

Slope Stability

Important factors that affect the slope stability of an area include the steepness of the slope, the relative strength of the underlying rock material, and the thickness and cohesion of the overlying colluvium. The steeper the slope and/or the less strong the rock, the more likely the area is susceptible to landslides. The steeper the slope and the thicker the colluvium, the more likely the area is susceptible to debris flows. Such areas can be identified on maps showing the steepness of slopes (Graham and Pike, 1998) when used in combination with a geologic map. Another indication of unstable slopes is the presence of old or recent landslides or debris flows.

Most of the proposed alignment and the alternatives do not cross any areas identified as an existing landslide, except along Del Sur Ridge where the alignment passes across two mapped landslides in the Pelona Schist. However, ~~although not crossed by the Project alignment,~~ other landslides have been mapped in the Project vicinity within several of the geologic units traversed by the Project alignment: the Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation (Dibblee, 1996b, 1996c, 1997a and 1997b). Unmapped landslides and areas of localized slope instability may be encountered in the hills traversed by the proposed Project alignment.

Soils

The soils along the proposed transmission line route reflect the underlying rock type, the extent of weathering of the rock, the degree of slope, and the degree of modification by man. Much of the route south of the ANF goes through developed land, while the portion traversing the ANF passes through undeveloped open space and the route north of ANF traverses a mixture of agricultural and undeveloped land. Soil mapping by the USDA National Resource Conservation Service (NRCS) has provided information for surface and near-surface subsurface soil materials. The Project alignment traverses portions of two NRCS soil survey reports, the Soil Survey of Antelope Valley, California (1970) and the Soil Survey of the Angeles National Forest Area, California (1980). A summary of the significant characteristics of the major soil units traversed by the Project is presented in Table C.5-2. These soil units are presented in approximate order of first significant occurrence along each portion of the alignment, each unit may occur numerous times and at several locations along the alignment.

Table C.5-2. Major Soils along the Proposed Antelope-Pardee 500-kV Transmission Line Route

Soil Name	Description	Hazard of Erosion on Roads and Trails[1,2]	Risk of Corrosion	
			Uncoated Steel	Concrete
North of ANF (Mile 0 to 5.7)				
~~Greenfield~~	~~Sandy Loam on 2-9 percent slopes~~	~~Moderate~~	~~Low~~	~~Low~~
Ramona	Coarse sandy loam on 2-5 and 5-9 percent slopes; and sandy loam on 9 to 30 percent slopes	Moderate to Severe	Moderate	Moderate
Greenfield	Sandy Loam on 2-9 percent slopes	Moderate	Low	Low
Vista	Coarse sandy loam on 15-30 and 30-50 percent slopes	Severe	Low	Low
Hanford	Coarse sandy loam and gravelly sandy loam on 2 to 9 percent slopes	Moderate	Low	Low
~~Vista~~	~~Coarse sandy loam on 15-30 and 30-50 percent slopes~~	~~Severe~~	~~Low~~	~~Low~~
Amargosa	Rocky coarse sandy loam on 9-55 percent slopes	Severe	Moderate	Low
Angeles National Forest (Mile 5.7 to 18.6)				
Trigo-Exchequer	Gravelly sandy loam, sandy loam, and loam on 30 to 60 and 60 to 100 percent slopes	Severe	NA	NA
Stonyford-Milsholm	Gravelly clay loam and clay loam on 30 to 70 percent slopes.	Severe	NA	NA
Lodo-Modesto	Gravelly loam with some loam and clay loam on 30 to 70 percent slopes	Severe	NA	NA
Calcixerollic Xerochrepts-Calleguas	Clay loam with some silty loam on 30 to 60 percent slopes	Severe	NA	NA
~~Trigo-Exchequer~~	~~Gravelly sandy loam, sandy loam, and loam on 30 to 60 and 60 to 100 percent slopes~~	~~Severe~~	~~NA~~	~~NA~~
South of ANF (Mile 18.6 to 25.6)				
Hanford	Sandy loam on 0-2 and 2-9 percent slopes	Slight to Moderate	Low	Low
Metz	Loam on 2-5 percent slopes; and loamy sand on 2-9 percent slopes	Moderate	High	Low
Saugus	Loam on 30-50 percent slopes	Severe	Low	Low

NA – data not available

1) Data related to hazard of erosion on roads and trails from the Hazard of Erosion and Suitability for Roads on ForestlandTable from the USDA NRCS online tabular data for the Antelope Valley (data version 1, 3/2004) and Angeles National Forest Area (data version 1, 12/2004) soil surveys. ~~Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.~~Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.

Corrosivity of soils is generally related to several key parameters: soil resistivity, presence of chlorides and sulfates, oxygen content, and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. High sulfate soils are corrosive to concrete and may prevent complete curing reducing its strength considerably. Low pH and/or low resistivity soils could corrode buried or partially buried metal structures.

The properties of soil which influence erosion by rainfall and runoff are ones which affect the infiltration capacity of a soil and those which affect the resistance of a soil to detachment and being carried away by falling or flowing water. Soils containing high percentages of fine sands and silt and that may ~~have~~ be low in density are generally the most erodible. These soil types generally coincide with soils such as young alluvium and other surficial deposits (Dibblee 1996b, c; 1997a, b; 2002), which likely occur in areas throughout the Project area. As the clay and organic matter content of these soils increases, the potential for erosion decreases. Clays act as a binder to soil particles, thus reducing the potential for erosion. However, while clays have a tendency to resist erosion, once eroded they are easily transported by water. Clean, well-drained, and well-graded gravels and gravel-sand mixtures are usually the least erodible soils. Soils with high infiltration rates and permeabilities reduce the amount of runoff.

Expansive soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variation in soil moisture content. Changes in soil moisture could result from rainfall, landscape irrigation, utility leakage, roof drainage, and/or perched groundwater. Expansive soils are typically very fine grained with a high to very high percentage of clay.

Mineral Resources

The Project traverses areas identified as sand and gravel resources by the State Mining and Geology Board in the Santa Clara River valley, however no active production/quarrying operations are located near the Project (CDMG 1987, 1999). The Project alignment does cross very near to one active quarry site, between Miles 13 and 14, off of Del Sur Ridge Road, the Bouquet Canyon Stone Quarry. The quarry is owned by Bouquet Canyon Stone Co., Inc. and is currently in operation mining rock used for decorative stone purposes. The rock they are mining is a sericite schist that is unique within the Pelona Schist for its variable-tone blue grey, gold color, very flat planar surfaces and tough structural integrity (Bouquet Canyon Stone Co., Inc., 2005). No other active mines or quarries are located in the Project vicinity.

The Pardee Substation is located adjacent to the Southeast Area of the Honor Rancho Oil and Gas Field and part of the Project alignment crosses the southeast corner of the field (DOGGR, 2005). The Southeast Area of the Honor Rancho field is a natural gas storage area, operated primarily by Southern California Gas Co. (SoCalGas) (DOGGR, 2002).

C.5.1.3 Seismic Hazards

Faults and Seismicity

The seismicity of southern California is dominated by the intersection of the north-northwest trending San Andreas Fault system and the east-west trending Transverse Ranges fault system. Both systems are responding to strain produced by the relative motions of the Pacific and North American Tectonic Plates. This strain is relieved by right-lateral strike-slip faulting on the San Andreas, and related faults, left-lateral strike slip on the Garlock Fault, and by vertical, reverse-slip or left-lateral strike-slip displacement on faults in the Transverse Ranges. The effects of this deformation include mountain building; basin development; deformation of Quaternary marine terraces; widespread regional uplift; and generation of earthquakes. Both the Transverse Ranges and northern Los Angeles County area are characterized by numerous geologically young faults. These faults can be classified as historically active, active, potentially active, or inactive, based on the following criteria (CGS, 1999):

- Faults that have generated earthquakes accompanied by surface rupture during historic time (approximately the last 200 years) and faults that exhibit aseismic fault creep[1] are defined as **Historically Active**.
- Faults that show geologic evidence of movement within Holocene time (approximately the last 11,000 years) are defined as **Active**.
- Faults that show geologic evidence of movement during the Quaternary (approximately the last 1.6 million years) are defined as **Potentially Active**.
- Faults that show direct geologic evidence of inactivity during all of Quaternary time or longer are classified as **Inactive**.

Although it is difficult to quantify the probability that an earthquake will occur on a specific fault, this classification is based on the assumption that if a fault has moved during the Holocene epoch, it is likely to produce earthquakes in the future. Blind thrust faults do not intersect the ground surface, and thus they are not classified as active or potentially active in the same manner as faults that are present at the earth's surface. Blind thrust faults are seismogenic structures and thus the activity classification of these faults is predominantly based on historic earthquakes and microseismic activity along the fault.

Since periodic earthquakes accompanied by surface displacement can be expected to continue in the study area through the lifetime of the proposed Project, the effects of strong groundshaking and fault rupture are of ~~primary~~ concern to safe operation of the proposed transmission line and associated facilities.

The Project area will be subject to ground shaking associated with earthquakes on faults of both the San Andreas and Transverse Ranges fault systems. Active faults of the San Andreas system are predominantly strike-slip faults accommodating translational[2] movement. The predominant active fault of the San Andreas Fault system in the Project area is the San Andreas Fault, which has been responsible for many of the damaging earthquakes in California in historical times.

Active reverse or thrust faults[3] in the Transverse Ranges include blind thrust faults[4] responsible for the 1987 Whittier Narrows Earthquake and 1994 Northridge Earthquake, and the range-front faults[5] responsible for uplift of the Santa Susana and San Gabriel Mountains. The Transverse Ranges fault system consists primarily of blind, reverse, and thrust faults accommodating tectonic compressional stresses in the region. Blind faults have no surface expression and have been located using subsurface geologic and geophysical methods. This combination of translational and compressional stresses gives rise to diffuse seismicity across the region.

Figure C.5-2 shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults within 50 miles of the Project alignment that are significant potential seismic sources are presented in Table C.5-3.

Table C.5-3. Significant Active and Potentially Active Faults in the Project Area

Name	Closest Distance to Project (miles)[1]	Estimated Max. Earthquake Magnitude[2, 3]	Fault Type and Dip Direction[3]	Slip Rate (mm/yr)[3, 4]
San Gabriel	0.6	7.2	Right Lateral Strike Slip, 90°	1.0
Holser	0.8	6.5	Reverse, 65° S	0.4
San Andreas – Mojave Segment	4.1	7.4	Right Lateral Strike Slip, 90°	30.0

1 Movement along a fault that does not entail earthquake activity.
2 Fault block movement in which the blocks have no rotational component, parallel features remain so after movement.
3 A fault with predominantly vertical movement in which the upper block moves upward in relation to the lower block, a thrust fault is a low angle reverse fault.
4 Blind thrust faults are low-angled subterranean faults that have no surface expression.
5 Faults along the front of mountain ranges responsible for the uplift of the mountains.

Table C.5-3. Significant Active and Potentially Active Faults in the Project Area

Name	Closest Distance to Project (miles)[1]	Estimated Max. Earthquake Magnitude[2, 3]	Fault Type and Dip Direction[3]	Slip Rate (mm/yr)[3, 4]
Northridge	6.2	7.0	Blind Thrust, 42° S	1.5
Santa Susana	6.6	6.7	Reverse, 55° N	5.0
Oak Ridge	8.5	7.0	Reverse, 65° S	4.0
Sierra Madre	9.0	6.7	Reverse, 45° S	2.0
Simi-Santa Rosa	10.2	7.0	Left Lateral Reverse Oblique, 60° N	1.0
San Cayetano	10.2	7.0	Reverse, 60° N	6.0
San Andreas – Carrizo Segment	11.7	7.4	Right Lateral Strike Slip, 90°	34.0
Verdugo	15.1	6.9	Reverse, 45° NE	0.5
Santa Ynez	20.8	7.1	Left Lateral Strike Slip, 90°	2.0
Garlock	23.5	7.3	Left Lateral Strike Slip, 90°	6.0
Hollywood	24.9	6.4	Left Lateral Reverse Oblique, 70° N	1.0
Anacapa-Dume	26.0	7.5	Reverse Left Lateral Oblique, 45° N	3.0
Upper Elysian Park Thrust	26.2	6.4	Blind Thrust, 50° NE	1.3
Santa Monica	26.3	6.6	Left Lateral Reverse Oblique, 75° N	1.0
Malibu Coast	26.8	6.7	Left Lateral Reverse Oblique, 75° N	0.3
Raymond	29.5	6.5	Left Lateral Reverse Oblique, 75° N	1.5
Newport-Inglewood	29.8	7.1	Right Lateral Strike Slip, 90°	1.0
Puente Hills Blind Thrust	29.9	7.1	Blind Thrust, 25° N	0.7
Clamshell-Sawpit	31.8	6.5	Reverse, 45° NW	0.5
Ventura-Pitas Point	32.5	6.9	Reverse Left Lateral Oblique, 75° N	1.0
Plieto	33.1	7.0	Reverse, 45° S	2.0
Palos Verdes	34.0	7.3	Right Lateral Strike Slip, 90°	3.0
Big Pine	35.7	6.9	Left Lateral Strike Slip, 90°	0.8
White Wolf	38.3	7.3	Reverse Left Lateral Oblique, 60° S	2.0
Whittier	45.0	6.8	Right Lateral Strike Slip, 90°	2.5
Cucamonga	47.3	6.9	Reverse, 45° N	5.0
San Jose	47.5	6.4	Left Lateral Reverse Oblique, 75° NW	0.5
Lenwood-Lockhart-Old Woman Springs	48.0	7.5	Right Lateral Strike Slip, 90°	0.6

Notes: 1) Fault distances obtained using the EQFault computer program (Blake, 2000), based on digitized data adapted and modified from the 2002 CGS fault database.
2) Maximum Earthquake Magnitude – the maximum earthquake that appears capable of occurring under the presently known tectonic framework, using the Richter scale.
3) Fault parameters from the CGS Revised 2002 California Probabilistic Seismic Hazard Maps report, Appendix A - 2002 California Fault Parameters.
4) References to fault slip rates are traditionally presented in millimeters per year.

Strong Groundshaking

An earthquake is classified by the amount of energy released, which traditionally has been quantified using the Richter scale. Recently, seismologists have begun using a Moment Magnitude (M) scale because it provides a more accurate measurement of the size of major and great earthquakes. For earthquakes of less than M 7.0, the Moment and Richter Magnitude scales are nearly identical. For earthquake magnitudes greater than M 7.0, readings on the Moment Magnitude scale are slightly greater than a corresponding Richter Magnitude.

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the Project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the Project area. Earthquakes occurring on faults closest to the Project area would most likely generate the largest ground motion.

The intensity of earthquake induced ground motions can be described using peak site accelerations, represented as a fraction of the acceleration of gravity (g). GIS data based on the CGS Probabilistic Seismic Hazard Assessment (PSHA) Maps was used to estimate peak ground accelerations along the Project alignment. PSHA Maps depict peak ground accelerations with a 10 percent probability of exceedance in 50 years. The results for the proposed Project are presented in Table C.5 4.

Table C.5-4. Peak Ground Acceleration

Approximate Proposed Transmission Line Mile	Total Length of Segments (miles)	Peak Ground Acceleration
15.1 to 20.5	5.4	0.4 to 0.5g
0 to 1.6, 10.8 to 15.1, and 20.5 to 25.2	10.6	0.5 to 0.6g
1.6 to 3.9, 7.8 to 10.8 and 25.2 to 25.6	5.7	0.6 to 0.7g
3.9 to 7.8	3.9	0.7 to 0.8g

A review of historic earthquake activity from 1800 to 1999 indicates that eight earthquakes of magnitude M 6.0 or greater have occurred within 50 miles (80 kilometers) of the proposed Project alignment (CGS, 2006). The M 5.9 Whittier Narrows earthquake of 1987 is also included in the table because it was a significantly damaging earthquake within 50 miles of the Project alignment. Also included in the table is the 1857 Fort Tejon Earthquake. The location of this earthquake is uncertain due to lack of seismic instrumentation at the time and due to the widespread damage and long rupture length; however, this very large earthquake produced surface rupture on the local strands of the San Andreas Fault. A summary of each of these eight earthquake events is presented in Table C.5-5.

Seven aftershocks measuring greater than M6.0 of larger earthquakes have also occurred within 50 miles of the Project alignment, but are not included in the table. An additional 26 earthquakes with magnitudes between M 5.5 and M 6.0 that occurred between 1800 and 1999 are located within 50 miles of the Project alignment, including numerous aftershocks of larger earthquakes. Figure C.5-2 shows locations of historic earthquakes in the Project area and surrounding region.

Fault Rupture

Perhaps the most important single factor to be considered in the seismic design of electric transmission lines and underground cables crossing active faults is the amount and type of potential ground surface displacement.

Two active and one potentially active faults cross the Project alignment, the San Andreas and San Gabriel Faults and the Clearwater Fault, respectively. Both the San Andreas and San Gabriel Faults are mapped as Earthquake Fault Zones[6] in the vicinity of the Project alignment crossing. Although the Project will not be subject to the regulations and guidelines related to the Alquist-Priolo Special Studies Zones Act because there will be no

[6] The Alquist-Priolo Special Studies Zones Act, passed in 1972, requires the establishment of "Earthquake Fault Zones" (formerly known as "special studies zones") along known active faults in California. In order to be designated as an "Earthquake Fault Zone" a fault must be "sufficiently active and well defined" according to State guidelines. Development of occupied structures within these zones is regulated and must conform to strict building restrictions and codes, which are enforced to reduce the potential for damage and loss of life due to fault displacement.

Table C.5-5. Significant Historic Earthquakes

Date	Approximate Distance (miles)	Earthquake Magnitude[1]	Name, Location, or Region Affected	Comments[2]
December 8, 1812	43.1	7.5?	Wrightwood Earthquake	Caused collapse of Mission at San Juan Capistrano resulting in the death of 40 people.
July 11, 1855	18.7	6.0	Los Angles Region	The bells at San Gabriel Mission Church were thrown down and twenty-six buildings in Los Angeles were damaged.
January 9, 1857	Unknown, currently assumed in the San Luis Obispo area.	Estimated from 7.9 to 8.25	Fort Tejon Earthquake	One of the largest earthquakes ever reported in the US. This earthquake caused damage from Monterey to San Bernardino and caused a surface rupture of greater than 220 miles in length. Due to sparse population of the time in it only resulted in 2 deaths. Average displacement along the fault was 15 feet, with a maximum displacement of 30 feet in the Carrizo Plain area.
January 16, 1857	34.0	6.3	Generally felt in the Los Angeles Region	Aftershock of the January 9, 1857 M7.9 Fort Tejon Earthquake.
July 29, 1894	48.1	6.2	Lytle Creek region	Felt from Bakersfield to San Diego. Minor damage in the Mojave and Los Angeles areas.
July 21,1952	45.3	7.3	Kern County Earthquake	Resulted in the death of 12 people and $60 million in property Damage.
February 9, 1971	6.6	6.6	San Fernando (Sylmar) Earthquake	This earthquake caused over $500 million in damage and resulted in 65 deaths. As A result of the damage from this earthquake, building codes were strengthened and the Alquist Priolo Special Studies Zone Act of 1972 was passed.
October 1, 1987	36.3	5.9	Whittier Narrows Earthquake	Resulted in eight deaths and $358 million in property damage. This earthquake occurred on a previously unknown blind thrust fault, the Puente Hills Fault.
January 17,1994	16.0	6.7	Northridge Earthquake	Resulted in 60 deaths and approximately $15 billion in property damage. Damage was significant and widespread, including collapsed freeway overpasses and more than 40,000 damaged buildings in Los Angeles, Ventura, Orange, and San Bernardino Counties.

Notes: 1) Earthquake magnitudes and locations before 1932 are estimated by Toppozada and others (1978, 1981, and 1982) based on reports of damage and felt effects.
2) Earthquake damage information compiled from the Southern California Data Center (SCEDC, 2005a and 2005b) and National Earthquake Information Center (NEIC, 2005) websites.

occupied structures constructed in the Earthquake Fault Zones as part of this Project, the presence of these mapped zones indicates significant potential for fault rupture in the areas the Project crosses the "zones". The limits of these zones in the vicinity of the Project alignment fault crossings are presented on Figure C.5-3.

Fault rupture has occurred historically within the Project area. The 1857 Fort Tejon Earthquake caused rupture of the local strands of the San Andreas Fault. Although future earthquakes could occur anywhere along the length of the San Andreas and San Gabriel Faults, only regional strike-slip earthquakes of magnitude 6.0 or greater are likely to be associated with surface fault rupture and offset (CGS, 1996). It is also important to note that earthquake activity from unmapped subsurface faults is a possibility that is currently not predictable.

Liquefaction

Liquefaction is the phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake induced, strong groundshaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude and frequency of earthquakes in the surrounding region. Saturated, unconsolidated silts, sands, and silty sands within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects (Youd, 1978). In addition, densification of the soil resulting in vertical settlement of the ground can also occur.

In order to determine liquefaction susceptibility of a region, three major factors must be analyzed. These include: (a) the density and textural characteristics of the alluvial sediments; (b) the intensity and duration of groundshaking; and (c) the depth to groundwater. Surface materials beneath the proposed alignment meet the criteria for liquefaction in the young alluvial deposits in the Santa Clara River valley, the Leona Valley, and in the alluvial and creek deposits of intervening drainages. Older and finer or coarser grained, indurated, and/or well-drained materials are less susceptible to liquefaction.

Seismic hazard mapping, delineating areas of potential liquefaction and seismically induced landslides, has been conducted by the State of California for four of the 7.5-Minute Quadrangles that the Project alignment traverses, the Del Sur, Sleepy Valley, Mint Canyon, and Newhall Quadrangles (CGS, 1998a, 1998b, 1999, 2003b, 2004). The Project alignment traverses mapped liquefaction hazard zones on the Del Sur, Mint Canyon, and Newhall Quadrangles.

Seismic Slope Instability

Other forms of seismically induced ground failures which may affect the Project area include ground cracking and seismically induced landslides. Landslides triggered by earthquakes have been a significant cause of earthquake damage, in southern California large earthquakes such as the 1971 San Fernando and 1994 Northridge earthquakes triggered landslides that were responsible for destroying or damaging numerous structures, blocking major transportation corridors, and damaging life-line infrastructure. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits. Local geologic units, such as the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations, that are prone to landslides with moderate to steep slopes, and previously existing landslides, both mapped and unmapped, are particularly susceptible to this type of ground failure. The proposed Project route crosses areas mapped as areas of potential earthquake-induced landslides on the CGS seismic hazard maps for the four mapped quadrangles along the alignment (CGS 1998a, 1998b, 1999, 2003b, 2004).

C.5.1.4 Paleontology

Determination of the "significance" of a fossil can only occur after a fossil has been found and identified by a qualified paleontologist. Until then, the actual significance is unknown. However, fossils are considered to be scientifically significant if they meet or potentially meet any one or more of the following criteria:

- Taxonomy – fossils that are scientifically judged to be important for representing rare or unknown taxa, such as defining a new species.
- Evolution – fossils that are scientifically judged to represent important stages or links in evolutionary relationships, or fill gaps or enhance under-represented intervals in the stratigraphic record.
- Biostratigraphy – fossils that are scientifically judged to be important for determining or constraining relative geologic (stratigraphic) age, or for use in regional to interregional stratigraphic correlation problems.

- Paleoecology – fossils that are scientifically judged to be important for reconstructing ancient organism community structure and interpretation of ancient sedimentary environments.
- Taphonomy – fossils that are scientifically judged to be exceptionally well or unusually or uniquely preserved, or are relatively rare in the stratigraphy.

The most useful designation for paleontological resources in an EIR document is the "sensitivity" of a particular geologic unit. Sensitivity refers to the likelihood of finding significant fossils within a geologic unit. The following levels of sensitivity recognize the important relationship between fossils and the geologic formations within which they are preserved.

- **High Sensitivity.** High sensitivity is assigned to geologic formations known to contain paleontological localities with rare, well-preserved, and/or 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 speaking, highly sensitive formations are known to 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 moderately preserved, common elsewhere, or stratigraphically long-ranging 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 (e.g., Pre-Holocene sedimentary rock units representing low to moderate energy, of marine to non-marine depositional settings).
- **Low Sensitivity.** Low sensitivity is assigned to geologic formations that, based on their relative youthful age and/or high-energy depositional history, are judged unlikely to produce important fossil remains. Typically, low sensitivity formations may produce invertebrate fossil remains in low abundance.
- **Marginal Sensitivity.** Marginal sensitivity is assigned to geologic formations that are composed either of pyroclastic volcanic rocks or metasedimentary rocks, but which nevertheless have a limited probability for producing fossil remains from certain sedimentary lithologies at localized outcrops.
- **Zero Sensitivity.** Zero sensitivity is assigned to geologic formations that are entirely plutonic (volcanic rocks formed beneath the earth's surface) in origin and therefore have no potential for producing fossil remains.

Significant California fossils are typically vertebrate fossils of late Quaternary and Tertiary age. The age of the geologic units, their terrestrial origin, and the discovery of vertebrates in late Quaternary and Tertiary-aged units in the region indicates that there is a likelihood that significant fossils may be found during excavation for new tower footings in locations along the Project route. The most likely locations would be where towers are placed on ridge tops and mesas capped by sandstone, siltstone or conglomerate (Lillegraven, 1973). Locations where metamorphic or crystalline rocks occur have no potential for paleontological resources (Zero sensitivity). Vertebrate fossils are known to occur in the late Quaternary and Tertiary sediments in the Project area, and the project alignment crosses formations with known fossil localities. A paleontologic survey for the Antelope Transmission Project was conducted for SCE by Dr. Grant Hurlburt, PhD (2004) from the California State University at Stanislaus, and is summarized below.

This study and additional internet research indicates that moderately to highly sensitive formations occur along the alignment. These units include the Anaverde Formation, the San Francisquito Formation, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation. Significant vertebrate fossils may also be present in older Quaternary alluvial deposits located below and on the eastern slopes of Portal Ridge; vertebrate fossils could include horse, mammoth, gopher snake, kingsnake, leopard lizard, cottontail rabbit, pocket mouse, kangaroo rat, and pocket gopher. Geologic units consisting of igneous (granitic rocks) and metamorphic rocks (Pelona Schist) will not contain fossils and thus have zero sensitivity.

The proposed Project alignment crosses a small area of the Pliocene Anaverde Formation in the San Andreas Rift zone; the SCE study indicates that this unit could contain significant fossils and internet research reveals that the Anaverde Formation is known to contain plant fossils (UCMP website, 2006) resulting in a moderate to high sensitivity for this unit. Between the Clearwater and San Francisquito faults (MPs 9.4 to 10.5) the alignment crosses the San Francisquito Formation, which although there are no known localities in the project vicinity, is known to contain vertebrate fossils, plesiosaur (UCMP website, 2006). Other fossils that could be encountered in the San Francisquito Formation include turtles and other reptiles, birds, and early mammals that were washed into the marine sediments (Hurlburt, 2004~~6~~).

The alignment crosses approximately 2.3 miles of the middle Miocene Mint Canyon Formation (MPs 17.5 to 19.8) which is known to contain fossil localities in the project area, although no know localities lie along the alignment. Significant fossils that could be encountered in the Mint canyon Formation include those of turtles, rabbits, dogs, pronghorn antelope, camel, and three genera of fossil horses (Hurlburt, 2004~~6~~). From approximately MP 19.8 to 20.5, the proposed transmission line alignment crosses the middle to late Miocene Castaic Formation which has two known fossil localities nearby; one with a fossil camel and the second with a rare fossil tapir specimen (Hurlburt, 2004~~6~~). The Plio-Pleistocene Saugus Formation is widespread beneath the project route, from approximately MPs 20.6 to 22.8, 24.1 to 25.1, and 25.2 to 25.3 (total of approximately 3.3 miles), and is known to contain numerous fossil localities, although few are within the project area and none are along the alignment. Significant fossils that may be encountered in the Saugus Formation include dogs and horses.

C.5.2 Regulatory Framework

Geologic resources and geotechnical hazards are governed primarily by local jurisdictions. The conservation elements and seismic safety elements of city and county general plans contain policies for the protection of geologic features and avoidance of hazards, but do not specifically address transmission line construction projects.

The two major environmental statutes that guide the design and construction of new transmission lines are NEPA and CEQA. These statutes set forth a specific process of environmental impact analysis and public review. In addition, the project owner must comply with several additional federal, state and local applicable statutes, regulations and policies. Relevant, and potentially relevant, statutes, regulations and policies are discussed below.

C.5.2.1 Federal

Geology and Mineral Resources

Protection of Geologic and Mineral Resources: National Environmental Policy Act (NEPA), as amended, 42 U.S.C. 4321, et seq., 40 C.F.R. Parts 1500-1508.

Regulations promulgated under 36 CFR 228 state that each District Ranger has jurisdiction over prospecting and mining operations on Forest Service lands, including permitting, approval of operation plans, and periodic inspection of mining facilities. It is the purpose of the regulations to set forth rules and procedures through which use of the surface of National Forest System lands in connection with operations authorized by the United States mining laws (30 U.S.C. 21–54), which confer a statutory right to enter upon the public lands to search for minerals, shall be conducted so as to minimize adverse environmental impacts on National Forest System surface resources.

Forest Service Manual (FSM) 2800 of the National Forest Service provides policy, management objectives, and regulations for Minerals and Geologic Resources. FSM 2800 consists of several chapters, each providing policy and regulation for a different aspect of mineral or geologic resource management, as follows: 2810 - Mining

Claims; 2820 - Mineral Leases, Permits, and Licenses; 2830 - Mineral Reservations and Rights Outstanding; 2840 – Reclamation; 2850 - Mineral Materials; 2860 - Forest Service Authorized Prospecting and Minerals Collecting; and 2880 - Geologic Resources, Hazards, and Services.

Paleontology

Protection of Paleontological Resources: National Environmental Policy Act (NEPA), as amended, 42 U.S.C. 4321, et seq., 40 C.F.R. Parts 1500-1508.

The Forest Service issues permits authorizing both project-related identification and mitigation efforts in addition to research related investigations based on the provisions of the Federal Land Policy and Management Act of 1976 (FLPMA) (43 USC 1701 1782) and the Antiquities Act of 1906. Regulations promulgated under 36 CFR 261 state that each Regional Forester has jurisdiction over "Protection of objects or places of historical, archaeological, geological or paleontological interest" (36 CFR 261.70(a)(5)), and that the following are prohibited: "Excavating, damaging, or removing any vertebrate fossil or removing any paleontological resource for commercial purposes without a special use permit" (36 CFR 261.9 (g)). FSM Chapter 2880 - Geologic Resources, Hazards, and Services contains policies and regulations related to paleontologic resource management and preservation. Forest Service policy makes the salvage of known paleontological resources a standard condition of their Special Use Permits. Treatment standards are specific to each forest and rely heavily upon implementation of a mitigation plan developed under the auspices of professional paleontologists at regional museums and universities.

C.5.2.2 State

Geologic and Seismic Hazards

California Environmental Quality Act (CEQA) (Pub. Resource Code sections 21000-21177.1). CEQA was adopted in 1970 and applies to most public agency decisions to carry out, authorize or approve projects that may have adverse environmental impacts. CEQA requires that agencies inform themselves about the environmental effects of their proposed actions, consider all relevant information, provide the public an opportunity to comment on the environmental issues, and avoid or reduce potential environmental harm whenever feasible. Relevant CEQA sections include those for protection of geological and mineral resources, protection of soil from erosion.

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (formerly the Special Studies Zoning Act) 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 overhead transmission lines, it does help define areas where fault rupture is most likely to occur. This Act groups faults into categories of active, potentially active, and inactive. Historic and Holocene age faults are considered active, late Quaternary and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geologic explorations in order to determine whether building setbacks should be established.

The Seismic Hazards Mapping Act (the Act) of 1990 (Public Resources Code, Chapter7.8, Division 2) directs the California Department of Conservation , Division of Mines and Geology [now called California Geological Survey (CGS)] to delineate Seismic Hazard Zones. The purpose of the Act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards. Cities, counties, and state agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. The Act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones.

The California Building Code (CBC, 2001) is based on the 1997 Uniform Building Code, with the addition of more extensive structural seismic provisions. Chapter 16 of the CBC contains definitions of seismic sources and the procedure used to calculate seismic forces on structures. As the proposed Project route lies within UBC Seismic Zone ~~3~~4, provisions for design should follow the requirements of Chapter 16. Chapter 33 of the CBC contains requirements relevant to the construction of underground transmission lines.

Paleontology

Protection of paleontological resources (certain fossils found in sedimentary rocks) in included in the Cultural Resources section of CEQA.

C.5.2.3 Local

The safety elements of General Plans for the cities and the County along the proposed alignment contain policies for the avoidance of geologic hazards and/or the protection of unique geologic features. A survey of General Plans along the proposed alignment indicated that most municipalities require submittal of construction and operational safety plans for proposed construction in areas of identified geologic and seismic hazards for review and approval prior to issuance of permits. County and local grading ordinances establish detailed procedures for excavation and grading required for underground construction.

C.5.3 Significance Criteria

A wide range of potential impacts, including loss of mineral and paleontological resources, slope instability including landslides, debris flows and slope creep, and seismic hazards including surface fault rupture, strong groundshaking, liquefaction, and seismically induced landslides, was considered in this analysis. Each of these potential geologic, soils, and paleontologic impacts is discussed in the following sections.

Geology and Soils

Geologic conditions were evaluated with respect to the impacts the Project may have on the local geology, as well as the impact that specific geologic hazards may have upon the transmission line and its related facilities. The significance of these impacts was determined on the basis of National Environmental Policy Act (NEPA) and CEQA statutes, guidelines and appendices, thresholds of significance developed by local agencies, government codes and ordinances, and requirements stipulated by California Alquist-Priolo statutes. Significance criteria and methods of analysis were also based on standards set or expected by agencies for the evaluation of geologic hazards.

Impacts of the Project on the geologic environment would be considered significant and require additional mitigation if Project construction or operation would result in any of the following criteria being met:

- Criterion GEO1: Unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by the proposed new transmission line towers and the associated construction activities.
- Criterion GEO2: Known mineral and/or energy resources would be rendered inaccessible by transmission line construction.
- Criterion GEO3: Geologic processes, such as landslides or erosion, could be triggered or accelerated by construction or disturbance of landforms.

- Criterion GEO4: Substantial alteration of topography would be required or could occur beyond that which would result from natural erosion and deposition.
- Criterion GEO5: High potential for earthquake-related ground rupture in the vicinity of major fault crossings along the transmission line route, resulting in probable damage to the transmission line structures.
- Criterion GEO6: High potential for seismically induced landslides, liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route, which will likely cause damage to proposed Project structures.
- Criterion GEO7: Presence of corrosive soils or other unsuitable soils, which would likely damage the transmission line support structures, including the substation foundations.
- Criterion GEO8: Potential of possible landslides on existing unstable slopes to damage the transmission line support structures.

Paleontology

Determination of the "significance" of a fossil can only occur after a fossil has been found and identified by a qualified paleontologist. Until then, the actual significance is unknown. The most useful designation for paleontological resources in an EIR document is the "sensitivity" of a particular geologic unit. Sensitivity refers to the likelihood of finding significant fossils within a geologic unit. Categories of "sensitivity" are defined in Section C.5.1.4. Fossils are considered to be scientifically significant if they meet or potentially meet any one or more of the following criteria:

- Taxonomy – fossils that are scientifically judged to be important for representing rare or unknown taxa, such as defining a new species
- Evolution – fossils that are scientifically judged to represent important stages or links in evolutionary relationships, or fill gaps or enhance under-represented intervals in the stratigraphic record
- Biostratigraphy – fossils that are scientifically judged to be important for determining or constraining relative geologic (stratigraphic) age, or for use in regional to interregional stratigraphic correlation problems
- Paleoecology – fossils that are scientifically judged to be important for reconstructing ancient organism community structure and interpretation of ancient sedimentary environments
- Taphonomy – fossils that are scientifically judged to be exceptionally well or unusually or uniquely preserved, or are relatively rare in the stratigraphy.

In southern California, generally fossils of land-dwelling vertebrates are considered the most significant.

Impacts of the Project on paleontology would be considered significant and require additional mitigation if Project construction or operation would result in any of the following criteria being met:

- Criterion GEO9: Directly or indirectly destroy a unique paleontological resource.

C.5.4 Applicant-Proposed Measures

The following are Applicant-Proposed Measures (APMs) to reduce geological resource related impacts:

Table C.5-6. Applicant-Proposed Measures – Geology, Soils, and Paleontology

Measure Number	SCE-Proposed Measure
Geology and Soils	
APM GEO-1	For new substation construction (e.g., expansion of Antelope Substation), specific requirements for seismic design will be followed based on the Institute of Electrical and Electronic Engineers' 693 "Recommended Practices for Seismic Design of Substation".

Table C.5-6. Applicant-Proposed Measures – Geology, Soils, and Paleontology

Measure Number	SCE-Proposed Measure
APM GEO-2	Prior to final design of substation facilities and transmission line tower foundations, a geotechnical study would be performed to identify site-specific geologic conditions in enough detail to support good engineering practice.
APM GEO-3	Transmission line and substation construction activities would be performed in accordance with the soil erosion/water quality protection measures specified in the Construction SWPPP.
Paleontology	
APM PAL-1	The following mitigation measures have been developed to reduce the potential impacts of project construction on paleontological resources to a less than significant level. The measures are derived from the guidelines of the SVP and meet the requirements of Kern and Los Angeles counties and CEQA. These mitigation measures have been used throughout California and have been demonstrated to be successful in protecting paleontological resources while allowing timely completion of construction: • A certified paleontologist would be retained by SCE to supervise monitoring of construction excavations and to produce a mitigation plan for the proposed Project. Paleontological monitoring would include inspection of exposed rock units and microscopic examination of matrix to determine if fossils are present. The monitor would have authority to temporarily divert grading away from exposed fossils in order to recover the fossil specimens. • If microfossils are present, the monitor would collect matrix for processing. In order to expedite removal of fossiliferous matrix, the monitor may request heavy machinery to assist in moving large quantities of matrix out of the path of construction to designated stockpile areas. Testing of stockpiles would consist of screen washing small samples to determine if significant fossils are present. Productive tests would result in screen washing of additional matrix from the stockpiles to a maximum of 6,000 pounds per locality to ensure recovery of a scientifically significant sample. • Quaternary Alluvium, Colluvium, and Quaternary Landslide Deposits have a low paleontological sensitivity level, and would be spot-checked on a periodic basis to insure that older underlying sediments are not being penetrated. • A certified paleontologist would prepare monthly progress reports to be filed with the client. • Recovered fossils would be prepared to the point of curation, identified by qualified experts, listed in a database to allow analysis, and deposited in a designated repository. • At each fossil locality, field data forms would record the locality, stratigraphic columns would be measured, and appropriate scientific samples submitted for analysis. • The certified paleontologist would prepare a final mitigation report to be filed with the client, the lead agency, and the repository.

C.5.5 Impact Analysis: Proposed Project/Action

The geologic, seismic, and paleontologic impacts of the proposed Project are discussed below under subheadings corresponding to each of the significance criterion presented in the preceding section. The analysis describes the impacts of the proposed Project related to geologic and seismic hazards, mineral resources, and paleontology and, for each criterion, determines whether implementation of the proposed Project would result in significant impacts.

Unique Geologic Features (Criterion GEO1)

No unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by the proposed Project. No impact would occur.

Known Mineral and/or Energy Resources (Criterion GEO2)

Although known sand and gravel resources, and a decorative stone quarry are located within the general Project area, none of the Project facilities are located within an active production area. Therefore, construction and operation of the Project is not expected to interfere with access to these resources. The access road for the

Bouquet Canyon Stone Company Quarry is located near the proposed Project along Del Sur Ridge. The quarry uses Del Sur Ridge Road for transportation of its product from the quarry. However, use of this road by construction traffic for the Project would not affect the ability of the quarry to transport their product. No impact would occur.

The Project alignment does cross the southeast corner of the Southeast Area of the Honor Rancho oil and gas field, but is not located near any active wells. However, this area is only operated as a natural gas storage reservoir by SoCalGas and is not expected to generate any additional gas resources other than the amount injected for storage. Therefore, construction and operation of the Project is not expected to interfere in access to or operation of the gas reservoir. No impact would occur would occur.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

Impact G-1: Excavation and grading during construction activities could cause slope instability.

Destabilization of natural or constructed slopes could occur as a result of construction activities due to excavation and/or grading operations. ~~Many of the hills and slopes crossed by the Project alignment are underlain by geologic units prone to landslides, including the Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation. Unmapped landslides and areas of localized slope instability may be encountered.~~Excavation operations associated with tower foundation construction and grading operations for temporary and permanent access roads and work areas could result in slope instability, resulting in landslides, slumps, soil creep, or debris flows. Slope failures are more likely to occur in areas with a history of previous failure, in weak geologic units exposed on unfavorable slopes and areas of weak, and in areas of fault-sheared rock. Many of the hills and slopes crossed by the Project alignment are underlain by geologic units prone to landslides, including the Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation. Unmapped landslides and areas of localized slope instability may be encountered. Instances of triggered slope failure could cause damage to nearby properties and roads, Project facilities and construction equipment, and could potentially result in injury to workers or the public. Prior to final design of substation facilities and transmission line tower foundations, SCE plans to perform geotechnical studies to identify site-specific geologic conditions (APM GEO-2). Mitigation Measure G-1 (Protect Against Slope Instability), which adds specific requirements to the planned geotechnical investigations prior to final Project design, ensures that potential impacts would be reduced to less-than-significant levels (**Class II**).

Mitigation Measure for Impact G-1

G-1 **Protect Against Slope Instability.** Design-level geotechnical investigations performed by the Applicant shall be performed by a licensed geologist or engineer and shall include evaluation of slope stability issues in areas of planned grading and excavation, and provide recommendations for development of grading and excavation plans. Based on the results of the geotechnical investigations, appropriate support and protection measures shall be designed and implemented to maintain the stability of slopes adjacent to newly graded or regraded access roads and work areas during and after construction. These measures shall include, but are not limited to, retaining walls, visqueen, removal of unstable materials, and avoidance of highly unstable areas. SCE shall document compliance with this measure prior to the start of construction by submitting a report to the CPUC and Forest Service AFS (for areas on NFS land) for review and approval. The report shall document the investigations and detail the specific support and protection measures that will be implemented.

Impact G-2: Erosion could be triggered or accelerated by construction or disturbance of landforms.

Excavation and grading for tower and substation foundations, work areas, and access roads could loosen soil or remove stabilizing vegetation and expose areas of loose soil. These areas, if not properly stabilized during construction, could be subject to increased soil loss and erosion by wind and stormwater runoff. Newly constructed and compacted engineered slopes can also undergo substantial erosion through dispersed sheet flow runoff. More concentrated runoff can result in the formation of small erosional channels and larger gullies, each compromising the integrity of the slope and resulting in significant soil loss. Portions of the Project alignments cross areas underlain by soils classified as having moderate to severe hazard of erosion on roads and trails. SCE has committed to perform transmission line and substation construction activities in accordance with the soil erosion/water quality protection measures specified in the Construction SWPPP (APM GEO-3). Implementation of Mitigation Measure G-2 (Minimization of Soil Erosion) ensures that potential impacts from erosion related to grading and use of access roads and work areas in areas of moderate to severe erosion potential during construction would be reduced to less-than-significant levels (**Class II**). Furthermore, Application of Mitigation Measure V-4a (Construct, Operate, and Maintain with Helicopters - see Section C.15, Visual Resources) would reduce the number of miles of access and spur roads that would be constructed or improved on NFS lands and would therefore reduce the amount of potential erosion.

Mitigation Measure for Impact G-2

G-2 **Minimization of Soil Erosion.** The Construction SWPPP for the Project shall include BMPs designed to minimize soil erosion along access roads and at work areas. Appropriate BMPs may include construction of water bars, grading road surfaces to direct flow away from natural slopes, use of soil stabilizers, and consistent maintenance of roads and culverts to maintain appropriate flow paths. Silt fences and straw bales installed during construction shall be removed to restore natural drainage during the cleanup and restoration phase of the project. Where access roads cross streams or drainages, they shall be built at or close to right angles to the streambeds and washes and culverts or rock crossings shall be used to cross streambeds and washes. Design of appropriate BMPs should be conducted by or under the direction of a qualified geologist or engineer.

Substantial Alteration of Topography (Criterion GEO4)

Impact G-3: Minor changes in topography due to excavation and grading.

Only limited shallow grading for access roads and work areas is anticipated and excavations are limited to the tower footing areas and within the substations for foundations. Therefore, substantial alteration[7] of the topography is not anticipated, however minor changes to topography would occur. The minor changes in topography anticipated due to grading of work areas and new access roads would be less than significant without mitigation (**Class III**). However, the implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) during construction and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) following construction would substantially reduce the effects of minor changes in topography due to grading for the Project.

[7] Substantial alteration of topography are changes in the character of the topography (slope and gradient) due to grading, excavation, or cut and fill that result in increased wind or water erosion due to resultant drainage pattern changes.

Earthquake-Related Ground Rupture (Criterion GEO5)

Impact G-4: Transmission line damaged by surface fault ruptures at crossings of active faults.

Project facilities would be subject to hazards of surface fault rupture at crossings of active traces of the San Andreas Fault between Miles 3.8 and 5.1 and of the San Gabriel Fault at approximately Mile 25.1 along the proposed alignment. Both of these faults are significant active faults with mapped Alquist-Priolo zones, as shown in Figure C.5-3, capable of multiple feet of offset. Hazards would not be as great where the proposed alignment crosses the trace of the potentially active Clearwater Fault at approximately Mile 9.4, shown on Figure C.5-2, which is only likely to generate small to moderate earthquakes with minor rupture or have minor triggered fault rupture in the event of a large local earthquake on the San Andreas or San Gabriel faults. Fault crossings where multiple feet of displacement are expected along active faults are best crossed as overhead lines with towers placed well outside the fault zone to allow for the flex in the cables to absorb offset. In addition to the geotechnical study required by APM GEO-2, Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) shall be completed prior to final Project design for the San Andreas and San Gabriel fault crossings to minimize the length of transmission line within fault zones. Impacts associated with overhead active fault crossings can be mitigated to less-than-significant levels (**Class II**).

Mitigation Measure for Impact G-4

G-4 **Minimize Project Structures Within Active Fault Zone.** Perform a geologic/geotechnical study to confirm location of mapped traces of active and potentially faults (the San Gabriel and San Andreas Faults) crossed by the alignment. ~~Any crossing of an active fault crossing (overhead or underground) shall be made as close to perpendicular to the fault as possible to make the segment cross the shortest distance within an active fault zone.~~ Tower locations shall be adjusted as necessary to avoid placing tower footings on or across mapped fault traces. Towers on either side of a fault shall be designed to provide a significant amount of slack to allow for potential fault movement and ground surface displacement.

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

Impact G-5: Project structures could be damaged by landslides, liquefaction, settlement, lateral spreading, and/or surface cracking resulting from seismic events.

There is a high potential for seismically induced landslides, liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route would likely cause damage to proposed Project structures. Seismically induced ground failure includes liquefaction, lateral spreading, seismic slope instability (landslide) and ground-cracking. Liquefaction occurs in low-lying areas where saturated noncohesive sediments are found. Lateral spreading occurs along waterfronts or canals where non-cohesive soils could move out along a free-face. Slope instability and ground-cracking can occur anywhere, however areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose, weak soils, and areas on or adjacent to existing landslide deposits.

Much of the Project alignment is located along hillsides or ridgelines in geologic units of moderate to steep slopes, which are particularly susceptible to this type of ground failure. Some of these areas, which include the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations, have a high possibility of seismic-induced ground failure in the form of landsliding or ground-cracking. Portions of the alignment are located in areas underlain by potentially liquefiable alluvial deposits and may be subject to liquefaction related phenomena during a seismic event, resulting in significant impact. Potentially liquefiable deposits include the young alluvial deposits in the Santa Clara River valley, the Leona Valley, and in the alluvial and creek deposits of intervening drainages. Prior to final design of substation facilities and transmission line tower foundations, SCE plans to perform geotechnical studies to identify site-specific geologic conditions (APM GEO-2). Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability) below would add specific requirements to the planned geotechnical investigations prior to final Project design and would reduce potentially significant impacts for all potential instances of seismically related ground failure along the Project route to less-than-significant levels (**Class II**).

Mitigation Measure for Impact G-5

G-5 **Geotechnical Investigations for Liquefaction and Slope Instability.** Since seismically induced ground failure has the potential to damage or destroy Project components, the Applicant shall perform design-level geotechnical investigations specifically to assess the potential for liquefaction, lateral spreading, seismic slope instability, and ground-cracking hazards to affect the approved Project and all associated facilities. Where these hazards are found to exist, appropriate engineering design and construction measures shall be incorporated into the Project designs. Such measures could include construction of pile foundations, ground improvement of liquefiable zones, installation of flexible bus connections, and incorporation of slack in cables to allow ground deformations without damage to structures.

Impact G-6: Project structures could be damaged by strong groundshaking.

Severe groundshaking should be expected in the event of an earthquake on the faults in the Project area. The alignment would also be subject to groundshaking from any of the major faults in the region. While the shaking would be less severe from an earthquake that originates farther from the alignment, the effects, particularly on the ridgelines, could be damaging to Project structures, a significant impact. It is likely that the Project facilities would be subjected to at least one moderate or larger earthquake occurring close enough to produce strong groundshaking in the Project area. SCE plans to perform geotechnical studies to identify site-specific geologic conditions prior to final design of substation facilities and transmission line tower foundations (APM GEO-2). In general, appropriate tower design which accounts for lateral wind and conductor loads will exceed creditable seismic loading due to groundshaking. To reduce Impact G-6 to a less-than-significant level, Mitigation Measure G-6 (Reduce Effects of Groundshaking) shall be implemented prior to final Project design to ensure that people or structures are not exposed to hazards associated with strong seismic groundshaking. Mitigation Measure G-6 adds specific requirements to the geotechnical investigations planned in APM GEO-2 and design requirements to ensure that Impact G-6 is reduced to a less-than-significant level (**Class II**).

Mitigation Measure for Impact G-6

G-6 **Reduce Effects of Groundshaking.** The design-level geotechnical investigations performed by the Applicant shall include site-specific seismic analyses to evaluate the peak ground accelerations for design of Project components. The Applicant shall follow the Institute of Electrical and Electronics Engineers (IEEE) 693 “Recommended Practices for Seismic Design of Substations” which has specific requirements to mitigate the types of damage that equipment at substations have had in the past from such seismic activity. These design guidelines shall be implemented during construction of substation modifications. Substation control buildings shall be designed in accordance with the Uniform Building Code for sites in Seismic Zone 4 with near-field factors.

Damage to Project structures from Unsuitable soils (Criterion GEO7)

Impact G-7: Buried tower and substation foundations could be damaged by corrosive soils.

Corrosive subsurface soils exist in places along proposed route. Corrosive soils could have a detrimental effect on concrete and metals. Depending on the degree of corrosivity of subsurface soils, concrete and reinforcing steel in concrete structures and bare-metal structures exposed to these soils could deteriorate, eventually leading to structural failures. Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) prior to construction would reduce potential impacts from corrosive soils to less-than-significant levels (**Class II**).

Mitigation Measure for Impact G-7

G-7 **Geotechnical Studies for Corrosive Soils**. In areas underlain by potentially corrosive soils or in areas of unknown corrosion potential (primarily in the ANF), the design-level geotechnical studies performed by the Applicant shall identify the presence, if any, of potentially detrimental soil chemicals, such as chlorides and sulfates. Appropriate design measures for protection of reinforcement, concrete, and metal-structural components against corrosion shall be utilized, such as use of corrosion-resistant materials and coatings, increased thickness of Project components exposed to potentially corrosive conditions, and use of passive and/or active cathodic protection systems.

Impact G-8: Tower and substation foundations could be damaged by expansive or collapsible soils.

Problematic soils can cause construction and maintenance hazards. Expansive soil, characterized by shrink-swell behavior, is a condition in which clay-rich soils react to changes in moisture content by expanding or contracting. Some of the natural soil types, identified primarily along the ANF portion of the alignment (Calcixerolic Xerochrepts-Calleguas soils) have moderate to high clay contents and many have moderate to high shrink-swell potential. Expansive soils may cause differential and cyclical foundation movements that can cause damage and/or distress to structures and equipment. Potential operational 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. Application of standard design and construction practices and implementation of Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils), below, prior to construction would reduce potential impacts to less-than-significant levels (**Class II**).

Mitigation Measure for Impact G-8

G-8 **Geotechnical Studies for Problematic Soils.** The Applicant shall perform design-level geotechnical studies to identify areas with potentially problematic soils and develop appropriate design features, including excavation of potentially problematic soils during construction and replacement with engineered backfill, ground-treatment processes, and redirection of surface water and drainage away from expansive foundation soils.

Damage to Transmission Line Support Structures from Landslides (Criterion GEO8)

Impact G-9: Transmission line structures could be damaged by landslides, earth flows, or debris slides.

Portions of the Project alignment cross sloping areas that are underlain by geologic formations prone to landslides (Pelona Schist, Mint Canyon Formation, Castaic Formation, and Saugus Formation) and near to existing landslides. Slope instability including landslides, earth flows, and debris flows has the potential to undermine foundations, cause distortion and distress to overlying structures, and displace or destroy Project components. Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to Project construction.

Mitigation Measure for Impact G-9

G-9 **Geotechnical Surveys for Landslides.** The design-level geotechnical investigation performed by the Applicant shall include detailed surveys to evaluate the potential for unstable slopes, landslides, earth flows, and debris flows along the approved transmission line route and in the vicinity of other Project facilities. Based on these surveys, approved Project facilities shall be located away from known landslides, very steep hillsides, debris-flow source areas, the mouths of steep sidehill drainages, and the mouths of canyons that drain steep terrain. Where these landslide hazard areas cannot be avoided, appropriate engineering design and construction measures shall be incorporated into the Project designs to minimize potential for damage to Project facilities.

Directly or indirectly destroy a unique paleontological resource (Criterion 9)

Impact G-10: Excavation for transmission line structures could damage unique or significant fossils.

Several fossil-bearing geologic formations with moderate to high sensitivity are located in the Project area, as discussed in Section C.5.1.4. SCE has proposed APM PAL-1 to avoid impacts to paleontological resources, which would require that certified paleontologist would be retained by SCE to supervise monitoring of construction excavations and to produce a mitigation plan for the proposed Project. Paleontological monitoring would include inspection of exposed rock units and microscopic examination of matrix to determine if fossils are present. The monitor would have authority to temporarily divert grading away from exposed fossils in order to recover the fossil specimens. A final mitigation report would be prepared by the certified Paleontologist to be filed with the client, the CPUC, and the designated repository for any recovered fossils. Mitigation Measure G-10 (Protection of Paleontological Resources) is similar to APM PAL-1, but it contains more detailed wording to ensure that Impact G-10 is reduced to a less-than-significant level (**Class II**).

Mitigation Measure for Impact G-10

G-10 **Protection of Paleontological Resources.** The certified paleontological monitor retained by SCE to supervise monitoring of construction activities shall be responsible for the following:

- Monitoring shall be conducted where excavation is being conducted in geologic units of moderate to high sensitivity. Monitoring need not be conducted where excavation is being conducted in geologic units with zero sensitivity, such as the Pelona Schist and granitic and volcanic formations.
- If fossils are present in the construction area, then grading shall be temporarily diverted away from exposed fossils in order to recover the fossil specimens.
- If microfossils are present in the construction area, the monitor shall collect matrix for processing. In order to expedite removal of fossiliferous matrix, the monitor may request heavy machinery to assist in moving large quantities of matrix out of the path of construction to designated stockpile areas.
- Stockpiles shall be tested by screen washing small samples to determine if significant fossils are present. Productive tests shall result in screen washing of additional matrix from the stockpiles to a maximum of 6,000 pounds per locality to ensure recovery of a scientifically significant sample.
- Young Quaternary Alluvium, Colluvium, and Quaternary Landslide Deposits, which have a low paleontological sensitivity level, shall be spot-checked on a periodic basis to insure that older underlying sediments are not being penetrated.

- Recovered fossils shall be prepared to the point of curation, identified by qualified experts, listed in a database to allow analysis, and deposited in a designated repository.
- At each fossil locality, field data forms shall record the locality, stratigraphic columns shall be measured, and appropriate scientific samples submitted for analysis.
- A monthly progress report shall be prepared by the supervising paleontological monitor and filed with the client. A final mitigation report shall be filed with the client, the lead agency, and the repository.
- If fossils are found on NFS lands, a special use permit will be required to allow for any recovery actions to occur.

C.5.6 Alternative 1: Partial Undergrounding of Antelope-Pardee Transmission Line

This section discusses geologic, seismic, and paleontologic setting for the portions of Alternative 1 that deviate from the proposed Project route. The setting of the portions of Alternative 1 that coincide with the proposed Project route is the same as for the proposed Project and is described in Section C.5.1. This consists of the replacement of two portions of the proposed overhead alignment by construction of underground segments that would primarily be located in existing roads, one along Del Sur Ridge and the other in Santa Clarita, and the addition of four transitions stations. Construction of the underground segments would require excavation of trenches up to 10 feet deep and vault excavations of up to 18 feet deep, grading of 2-3 acre sites for the transition stations, and additional access road grading along Del Sur Ridge.

C.5.6.1 Affected Environment

Physiography

The physiographic setting of Alternative 1 is the same as the proposed Project alignment and is discussed in Section C.5.1.1.

Geologic Setting

The general geologic setting of Alternative 1 is the same as the proposed Project. Geologic conditions along the portion of Alternative 1 where it diverges from the proposed alignment are summarized in Table C.5-7. The table includes: name of the geologic formation or feature; the geologic age of the formation or feature, a description and comments about the formation's general rock type, lithology, susceptibility to specific geologic hazards as appropriate; and general excavation characteristics of the unit related to excavation or drilling of tower and structure foundations. Descriptions of geologic units in the Project area are based on published geologic quadrangle maps by Thomas Dibblee (1996b; 1997a).

Table C.5-7. Geologic Units along Alternative 1

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
0-11.3	Same as proposed Project alignment			
11.3-15.2	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
15.2-22.7	Same as Proposed Project Route from Project Mile 15.2 to 22.7			
22.7-23.7	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified landslide hazard potential	Easy to Moderate

Table C.5-7. Geologic Units along Alternative 1

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
23.7-24.3	Alluvium	Holocene	Alluvial sand, gravel, and clay on the floor of San Francisquito Canyon. Liquefaction hazard potential.	Easy
24.3-26.0	Saugus Fm	Pliocene/ Pleistocene	Weakly indurated, terrestrial fluviatile conglomerate; identified landslide hazard potential	Easy to Moderate
26.0-26.2	Alluvium	Holocene	Alluvial sand, gravel, and clay in Santa Clara River valley/floodplain. Liquefaction hazard potential.	Easy

Notes: 1) Mile markers for alternative are based on length of entire alternative from Antelope to Pardee Substation.
2) Excavation characteristics are very generally defined as "easy," "moderate," or "difficult" based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Slope Stability

Although most of the Alternative 1 segments do not cross areas identified as an existing landslide, several moderate to small landslides are mapped along the segments. Additionally, numerous landslides have been mapped in the vicinity within geologic units traversed by the alignment: the Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation (Dibblee, 1996b and 1997a). Unmapped landslides and areas of localized slope instability may be encountered in the hills traversed by the alignment.

Soils

Soil mapping by the USDA National Resource Conservation Service (NRCS) has provided information for surface and near-surface subsurface soil materials. The Alternative 1 alignment traverses areas included in the NRCS Antelope Valley soil survey and the Angeles National Forest Area soil survey. Alternative 1 traverses numerous soil types, and a summary of the significant characteristics of the major soil units traversed by Alternative 1 to the intersection with the proposed Project alignment, is presented in Table C.5-8. These soil units are presented in approximate order of first significant occurrence along the alignment, each unit may occur numerous times and at several locations along the alignment.

Table C.5-8. Major Soils along the Alternative 1 Route Segments

Soil Name	Description	Hazard of Erosion on Roads and Trails[1]	Risk of Corrosion	
			Uncoated Steel	Concrete
Del Sur Ridge (ANF) Underground Segment and Transition Stations				
Lodo-Modesto	Gravelly loam with some loam and clay loam on 30 to 70 percent slopes	Severe	NA	NA
Santa Clarita Underground Segment and Transitions Stations				
Hanford	Sandy to coarse sandy loam on 5 to 9 percent slopes, and gravelly sandy loam on 2 to 9 percent and 9 to 30 percent slopes	Moderate	Low	Low
Saugus	Loam on 30-50 percent slopes	Severe	Low	Low
Castaic-Balcom	Silty clay loam on 30 to 50 percent slope	Severe	High	Low

1) Data related to hazard of erosion on roads and trails from the Hazard of Erosion and Suitability for Roads on ForestlandTable from the USDA NRCS online tabular data for the Antelope Valley (data version 1, 3/2004) and Angeles National Forest Area (data version 1, 12/2004) soil surveys.
2) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.
~~Table Notes: 1) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and that major erosion control measures are needed.~~

Mineral Resources

The Del Sur Ridge underground segment of Alternative 1 crosses very near to the Bouquet Canyon Stone Company Quarry and runs along Del Sur Ridge Road. This road serves as the main access road for the quarry, as well as the quarry entrance road. The Santa Clarita segment of Alternative 1 traverses areas identified as sand and gravel resources in the Santa Clara River valley, however no active production/quarrying operations are located near this portion of the alignment (CDMG, 1999).

Faults and Seismicity

Because of the minor differences in alignment of Alternative 1 and the proposed Project, the seismic setting, including regional faulting, strong groundshaking, fault rupture, liquefactions, and seismic slope stability, for Alternative 1 are similar to that of the proposed Project route. The sections below discuss the seismic setting along the segments of Alternative 1 that differ from the proposed Project.

Figure C.5-2 shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults that represent significant potential seismic sources are presented in Table C.5-3.

Strong Groundshaking

GIS data based on the CGS Probabilistic Seismic Hazard Assessment (PSHA) Maps was used to estimate peak ground accelerations along the underground segments of Alternative 1, the results are presented in Table C.5-9. PSHA Maps depict peak ground accelerations with a 10 percent probability of exceedance in 50 years.

Table C.5-9. Peak Ground Acceleration along Alternative 1

Approximate Alternative 1 Transmission Line Mile	Total Length of Segments (miles)	Peak Ground Acceleration
15.1 to 15.2	0.1	0.4 to 0.5g
11.3 to 15.1 and 22.7 to 25.7	6.9	0.5 to 0.6g
25.7 to 26.2	0.5	0.6 to 0.7g

Fault Rupture

The Santa Clarita underground segment of Alternative 1 crosses the San Gabriel Fault Zone just south of the proposed Project alignment fault crossing near approximately Alternative 1 Mile 25.7. The San Gabriel Fault is located within an Alquist-Priolo zone where Alternative 1 crosses, as shown in Figure C.5-3.

Liquefaction

Portions of the Santa Clarita underground segment of Alternative 1 are underlain by potentially liquefiable materials, primarily alluvial deposits in San Francisquito Canyon, Santa Clara River valley, and in the alluvial and creek deposits of smaller side drainages. These areas are also identified as liquefaction hazard zones on the CGS seismic hazard map for the Newhall 7.5-Minute Quadrangle.

Seismic Slope Instability

The Pelona Schist and Saugus Formations, which underlie the underground segments of Alternative 1, are prone to landslides and will likely be susceptible to seismically induced landsliding in areas with moderate to steep slopes and previously existing landslides. The CGS seismic hazard map for the Newhall Quadrangle also maps many of the moderate to steep slopes crossed by Alternative 1 as having earthquake-induced landslide potential. CGS hazard mapping has not been conducted for the area at and near the Del Sur Ridge underground segment (the Green Valley Quadrangle).

Paleontology

The Saugus Formation, located along the Santa Clarita underground segment of Alternative 1 is a highly sensitive unit paleontologically and may contain dog and horse fossils (Hurlburt, 20046). The Del Sur Ridge underground segment of Alternative 1 is underlain by metamorphic rocks, Pelona Schist, and has no potential for paleontological resources (Zero sensitivity).

C.5.6.2 Impacts and Mitigation Measures

The geologic, seismic, and paleontologic impacts of Alternative 1 are discussed below under subheadings corresponding to each of the significance criterion presented in Section C.5.3.

Unique Geologic Features (Criterion GEO1)

As with the proposed Project, no unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected. No impact would occur would occur.

Known Mineral and/or Energy Resources (Criterion GEO2)

Impact G-11: Construction activities would interfere with access to known mineral resources

The Del Sur Ridge underground segment of Alternative 1 segment crosses and runs along Del Sur Ridge Road (6N18), the access road along the top of Del Sur Ridge and would therefore not reduce accessibility to the stone resources during Project operation. However, construction operations for Alternative 1, which would include excavations for trenches and vault structures and construction vehicle traffic such as large excavators and haulers for fill and spoils, along Del Sur Ridge Road could potentially interfere with daily trucking operations to and from the quarry. This would be a significant impact. Implementation of Mitigation Measure G-11 (Coordination with Quarry Operations) would reduce potential impacts to less than significant (**Class II**).

Mitigation Measure for Impact G-11

G-11 **Coordination with Quarry Operations.** Operations and management personnel for the Bouquet Canyon Stone Company Quarry shall be consulted regarding trucking schedules and quarry access requirements, and shall coordinate construction activities across and along necessary quarry access roads in a manner to limit interference with quarry trucking operations. A plan to avoid or minimize interference with quarry operations shall be prepared in conjunction with mine/quarry operators prior to construction. SCE shall document compliance with this measure prior to the start of construction by submitting the plan to the CPUC and ANF for review.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

As with the proposed Project excavation for foundations, tower footing, and grading of access roads could result in could result in slope instability in sloping areas underlain by landslide prone geologic units (Impact G-1) and could loosen soil and cause excessive erosion in areas with soils having moderate to severe potential for erosion (Impact G-2). An increased potential for Impacts G-1 and G-2 is present along the underground portions of Alternative 1, where excavation of trenches along ridgelines and near slopes and grading for the transition station pads results in substantial ground disturbance in areas underlain by landslide prone geologic units and soil units with moderate to severe erosion potential.

~~However, implementation of~~Mitigation Measure G-1 (Protect Against Slope Instability) requires that planned geotechnical studies (APM GEO-2) be conducted by a licensed geologist or engineer and include recommendations for grading and excavation measures to protect against slope instability, such as (but not necessarily limited to) the use of retaining walls, visqueen, removal of unstable materials, and the avoidance of highly unstable areas. Mitigation Measure G-1 further requires that these recommendations be submitted to the CPUC and USFS prior to construction for review and approval. With full implementation of Mitigation Measure G-1, and the recommendations of its corresponding geotechnical studies, as approved by the CPUC and Forest Service, ~~would reduce Impact G-1 for this alternative to~~impacts related to slope instability would be reduced to a less-then-significant level **(Class II).** In addition, ~~implementation of~~Mitigation Measure G-2 (Minimization of Soil Erosion) requires that the Construction SWPPP include BMPs designed to minimize erosion related to grading, access roads and work areas in areas having moderate to severe erosion potential. Appropriate types of BMPs include, but would not necessarily be limited to, the construction of water bars, the use of soil stabilizers, site specific grading techniques to minimize surface water flow erosion, and the use of silt fences and straw bails during construction. Approval of the SWPPP and the BMPs contained within it would be required prior to construction. With full implementation of Mitigation Measure G-1 and the BMPs contained within the SWPPP, impacts related to erosion would be reduced ~~Impact G-2 for this alternative~~ to less-than-significant levels (**Class II**).

Substantial Alteration of Topography (Criterion GEO4)

Ground disturbance along Alternative 1 for construction of the overhead transmission line segments is characterized by shallow grading for access roads and work areas and excavations limited to the tower footing areas and within the substations for foundations, similar to the proposed Project. Therefore, substantial alteration of the topography (changes in slope and gradient that would increase wind or water erosion due to drainage pattern modifications) is not anticipated along the overhead portions of the alignment, however minor changes to topography will occur. The minor changes in topography (Impact G-3) anticipated due to grading of work areas and new access roads are a less than significant impact (**Class III**). Although this impact is less than significant, the implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) during construction, and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) following construction would substantially reduce the effects of minor changes in topography due to grading associated with the overhead portion of the project.

The underground segments of Alternative 1 would require extensive grading and excavation for trenches and vaults, and cut and fill grading for the transition station pads, and thus would introduce additional topographic disturbances not associated with overhead transmission line construction. In total, approximately 6.9 miles of the transmission line would be constructed underground, and the construction of transition stations (approximately two to three acres in size) at each end of the two underground segments would also be required. Impacts due to topographic effects due to construction of these underground segments and their transition stations could be significant, as discussed in further detail below in Impact G-12.

Impact G-12: Installation of underground infrastructure would permanently alter topography.

Installation of the underground segments of Alternative 1 would require substantial excavation to install underground duct banks and vaults. Within the City of Santa Clarita, the area surrounding the excavated areas would be returned to their original condition, including repair of streets and other local infrastructure. For the underground segment along Del Sur Ridge, substantial cut-and-fill grading would be required in order to achieve a level grade acceptable for installation of the underground duct banks and conductor. In addition, level pads 2-3 acres in size would need to be created for the two transition stations on the ridge at each end of the underground segment. As a result, the existing topography along Del Sur Ridge would be permanently altered in order to meet the requirements for installation and maintenance of the underground transmission line, a significant impact. Mitigation Measure B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities), described in Section C.3 (Biological Resources), would be implemented in order to minimize this impact by re-establishing existing and natural vegetation along the ridge, in conjunction with implementation of Mitigation Measure G-2 (Minimization of Soil Erosion) to minimize erosion resulting from the changes in surface topography. Implementation of these mitigation measures reduces the severity of the permanent topographic alteration caused by Impact G-12 to a less-than-significant level (**Class II**).

Earthquake-Related Ground Rupture (Criterion GEO5)

Similar to the proposed Project, Alternative 1 would be subject to hazards of substantial surface fault rupture and offset at overhead crossings of active traces of the San Andreas Fault and lesser fault rupture hazards where the overhead portion of the alternative crosses the trace of the potentially active Clearwater Fault (Impact G-4), a significant impact. Implementation of Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) prior to construction would reduce impacts associated with overhead active fault crossings to less-than-significant levels (**Class II**). Additional and increased potential for damage due to fault rupture is present along the Santa Clarita underground segment where the alignment crossed the active San Gabriel Fault, discussed in further detail below in Impact G-13.

Impact G-13: Underground transmission line damaged by surface fault ruptures at crossing of the active San Gabriel Fault.

The underground portion of Alternative 1 in the Santa Clarita area crosses the Alquist-Priolo mapped San Gabriel Fault Zone just south of the proposed Project alignment fault crossing near approximately Alternative 1 Mile 25.7. Rupture and displacement of the fault at this crossing could result in significant damage to the underground cables~~, a significant impact~~. Although no mitigation measure can reduce the likelihood of fault rupture, proper preparation and design can reduce the potential for damage to underground power lines crossing the fault rupture zone. In the event of damage to the lines due to fault rupture, this mitigation measure should significantly reduce the amount of time necessary to effect repairs. Mitigation Measure G-13 (Minimize Damage to Underground Transmission Lines) would minimize damage to the underground segment of the transmission line at the San Gabriel fault crossing and shall be completed prior to construction. Implementation of this mitigation would result in a less-than-significant impact (**Class II**).

Mitigation Measure for Impact G-13

G-13 **Minimize Damage to Underground Transmission Lines.** Site-specific geotechnical investigations will be performed at locations where underground portions of the proposed transmission line crosses the mapped San Gabriel Fault Zone and intersects individual fault traces. Where significant potential for fault surface rupture is identified, appropriate engineering measures, such as installing breakaway connections and strategically locating splice boxes outside of the fault zone, will be implemented to protect sensitive equipment and limit the extent of potential repairs. ~~Additionally, underground crossing of the active fault traces shall be made as close to perpendicular to the fault as possible to make the segment cross the shortest distance within an active fault zone and cable vaults on either~~

~~side of the fault shall be oversized, leaving as much slack as possible in the cables to absorb any offset.~~

Operation and maintenance measures will be implemented to prepare for potential fault-rupture scenarios and facilitate timely repair of facilities. Preparation measures will include, but no be limited to, storage and maintenance of spare parts and equipment that may be needed to repair or temporarily bypass portions of the transmission line damaged as a result of fault surface rupture. Spare parts and equipment would be stored at the nearby Pardee Substation or other nearby facilities.

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

Alternative 1 would have similar potential for seismically induced landslides, liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route as the proposed Project. These phenomena could cause damage to Alternative 1 structures (Impact G-5). As much of the alignment is located along hillsides or ridgelines, the possibility of seismic-induced ground failure in the form of landsliding or ground-cracking is high. Some portions of the alignment are located in areas underlain by potentially liquefiable alluvial deposits and may be subject to liquefaction related phenomena during a seismic event. Most of the Santa Clarita underground segment of this alternative is underlain by young alluvium, in San Francisquito Canyon and the Santa Clara River Valley, and may be particularly susceptible to liquefaction related damage, a significant impact. Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability) prior to Project design would reduce potentially significant impacts for all potential instances of seismically related ground failure for this alternative to less-than-significant levels (**Class II**).

As with the proposed Project, the Alternative 1 alignment would be subject to moderate to severe groundshaking from any of the major faults in the region, which could also result in damage to Project structures (Impact G-6). It is likely that the Project facilities would be subjected to at least one moderate or larger earthquake occurring close enough to produce strong groundshaking in the Project area. To reduce potential impacts to less-than-significant levels (**Class II**), Mitigation Measure G-6 (Reduce Effects of Groundshaking) shall be implemented prior to construction.

Damage to Project structures from Unsuitable soils (Criterion GEO7)

The same soil types with the same soil characteristics are located along Alternative 1 as along the proposed Project, resulting in the same potential impacts from corrosive and other problematic soils (Impacts G-7 and G-8, respectively). Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) during the applicant proposed geotechnical investigations would reduce Impact G-7 to a less-than-significant level. Application of Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils) for Impact G-8 prior to Project design and construction would reduce potential impacts from unsuitable soils to less-than-significant levels (**Class II**).

Damage to Transmission Line Support Structures from Landslides (Criterion GEO8)

As with the proposed Project, much of the Alternative 1 alignment crosses hillside areas underlain by landslide prone geologic units (Pelona Schist and Saugus Formation) and is crossed by several small existing landslides. Landslides, earth flows, and debris flows could potentially cause damage to Project structures by to undermining tower foundations, and cause distortion and distress to underground and overlying structures (Impact G-9). Foundations of overlying structures could be shifted if located on or a landslide occurs beneath it, potentially resulting in damage to buildings and facilities attached to the foundations. Overlying structures could also be damaged if slope failures from above run into structures causing damage to structure supports or pushing structures off their foundations. Underground power lines and their accompanying facilities and structures could be damaged by landslides near to and across the alignment that result in movement of the surrounding soils. Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to final Project design.

Directly or indirectly destroy a unique paleontological resource (Criterion GEO9)

The same fossil-bearing geologic formations are located along the Alternative 1 alignment as the proposed Project. However, because the construction of the underground segment in the Santa Clarita area would result in more excavation and ground disturbance in the potentially fossil bearing Saugus Formation, this alternative has a greater potential for damage to or destruction of significant fossils (Impact G-10), a significant impact. Despite this increased potential impact, implementation of Mitigation Measure G-10 (Protection of Paleontological Resources) would reduce Impact G-10 to a less-than-significant level (**Class II**).

C.5.7 Alternative 2: Antelope-Pardee East Mid-Slope

This section discusses geologic, seismic, and paleontologic setting for the portions of Alternative 2 that deviate from the proposed Project route. Alternative 2 is identical to the proposed Project, except between Project Mile 5.7 and Mile 17.5. Alternative 2 would follow a similar route to the proposed Project, but in the ANF area would shift the alignment off the top of the Del Sur Ridge to the east towards Bouquet Canyon. The setting of the portions of Alternative 2 that coincide with the proposed Project route is the same as for the proposed Project and is described in Section C.5.1.

C.5.7.1 Affected Environment

Physiography

The physiographic setting of Alternative 2 is the same as the proposed Project alignment and is discussed in Section C.5.1.1.

Geologic Setting

The general geologic setting of Alternative 2 is the same as the proposed Project. Geologic conditions along the portion of Alternative 2 where it diverges from the proposed alignment are summarized in Table C.5-10. Descriptions of geologic units along Alternative 2 are based on published geologic quadrangle maps by Thomas Dibblee (1997a, b).

Table C.5-10. Geologic Units along Alternative 2

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
0-5.7	Same as proposed Project alignment Mile 0-5.7			
5.7-8.4	Quartz Diorite-Gneiss Complex	Late Mesozoic and older	Granitic rocks with some gray gneiss, variable weathering profile, possible landslide hazard potential	Difficult
8.4	San Francisquito Fault	Pre-Quaternary	Likely inactive, no significant fault rupture hazard	Not Applicable
8.4-8.7	Alluvium	Holocene	Alluvial gravel, sand, and silt. Potential liquefaction hazard. Small outcrop of Pelona Schist at about Mile 8.6.	Easy
8.7-18.6	Pelona Schist	Unknown, assumed late	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult

Table C.5-10. Geologic Units along Alternative 2

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
		Miocene or older		
18.6-26.7	Same as Proposed Project Route from Project Mile 17.5-25.6			

Notes: 1) Mile markers for alternative are based on length of entire alternative from Antelope to Pardee Substation.
2) Excavation characteristics are very generally defined as "easy," "moderate," or "difficult" based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Slope Stability

Several moderate sized landslides are mapped along Alternative 2 where it crosses the landslide prone Pelona Schist. Additionally, numerous other small to moderate sized landslides are mapped in the alignment vicinity within the Pelona Schist (Dibblee, 1997a, b). Areas with unmapped landslides and areas of localized slope instability may also be encountered along the hills traversed by the alignment.

Soils

Soil mapping by the USDA National Resource Conservation Service (NRCS) has provided information for surface and near-surface subsurface soil materials. The Alternative 2 alignment traverses areas included in the NRCS Angeles National Forest Area soil survey. Alternative 2 traverses several soil types, and a summary of the significant characteristics of the major soil units traversed by the portion of Alternative 2 that differs from the proposed Project is presented in Table C.5-11. These soil units are presented in approximate order of first significant occurrence along the alignment, each unit may occur numerous times and at several locations along the alignment.

Table C.5-11. Major Soils along the Alternative 2 Route

Soil Name	Description	Hazard of Erosion on Roads and Trails[1, 2]	Risk of Corrosion	
			Uncoated Steel	Concrete
Angeles National Forest				
Trigo-Exchequer	Gravelly sandy loam, sandy loam, and loam on 30 to 60 and 60 to 100 percent slopes	Severe	NA	NA
Lodo-Tujunga	Gravelly loam and gravelly loamy sand on 2 to 50 percent slopes.	Severe	NA	NA
Lodo-Modesto	Gravelly loam with some loam and clay loam on 30 to 70 percent slopes	Severe	NA	NA
Exchequer	Sandy loam on 30 to 60 percent slopes	Severe	NA	NA

1) Data related to hazard of erosion on roads and trails from the Hazard of Erosion and Suitability for Roads on ForestlandTable from the USDA NRCS online tabular data for the Antelope Valley (data version 1, 3/2004) and Angeles National Forest Area (data version 1, 12/2004) soil surveys.
2) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.

~~Table Notes: 1) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and that major erosion control measures are needed.~~

Mineral Resources

The Bouquet Canyon Stone Quarry is located in the vicinity of the Alternative 2 alignment, however the quarry is located west and upslope of the alignment ~~No active production/quarrying operations are located near the alignment~~ and therefore there should be no impact from this alignment on mineral resources (CDMG, 1999).

Faults and Seismicity

Because alignment of Alternative 2 and the proposed Project are geographically close together, the seismic setting, including regional faulting, strong groundshaking, fault rupture, and liquefaction, ,for Alternative 2 are to the same as that of the proposed Project route. However, due to Alignment 2 being located on slopes underlain by existing landslides and by landslide prone Pelona Schist versus along the ridge top, setting related to seismic slope stability differs. The sections below discuss the seismic setting along the segments of Alternative 2 that differ from the proposed Project

Figure C.5-2 shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults that represent significant potential seismic sources are presented in Table C.5-3.

Strong Groundshaking

GIS data based on the CGS Probabilistic Seismic Hazard Assessment (PSHA) Maps was used to estimate peak ground accelerations along the underground segments of Alternative 2, the results are presented in Table C.5-12. PSHA Maps depict peak ground accelerations with a 10 percent probability of exceedance in 50 years.

Table C.5-12. Peak Ground Acceleration along Alternative 2

Approximate Alternative 2 Transmission Line Mile	Total Length of Segments (miles)	Peak Ground Acceleration
5.7 to 7.9	2.2	0.4 to 0.5g
7.9 to 11.6	3.7	0.5 to 0.6g
11.6 to 16.1	4.5	0.6 to 0.7g
16.1 to 18.6	2.5	0.7 to 0.8g

Fault Rupture

Alternative 2 does not cross any active or potentially active fault traces along the segment that diverges from the proposed Project route, therefore fault rupture along this portion of Alternative 2 is unlikely.

Liquefaction

A small portion of the Alternative 2 alignment is underlain by potentially liquefiable alluvial deposits on the valley floor of Bouquet Canyon east of Bouquet Reservoir. However, it is unlikely that tower structures will be placed on the floor of this canyon, resulting in minimal potential for liquefaction related damage to structures.

Seismic Slope Instability

The Pelona Schist that underlies a large portion of the part of Alternative 2 that differs from the proposed Project is prone to landslides and will likely be susceptible to seismically induced landsliding in areas with moderate to steep slopes and previously existing landslides. CGS seismic hazard mapping has not been conducted for this area (the Green Valley Quadrangle).

Paleontology

The portion of Alternative 2 that differs from the proposed Project is underlain primarily by granitic and metamorphic rocks that have no potential for paleontological resources (Zero sensitivity).

C.5.7.2 Impacts and Mitigation Measures

The geologic, seismic, and paleontologic impacts of Alternative 2 are discussed below under subheadings corresponding to each of the significance criterion presented in Section C.5.3.

Unique Geologic Features (Criterion GEO1)

As with the proposed Project, no unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by construction of Alternative 2. No impact would occur.

Known Mineral and/or Energy Resources (Criterion GEO2)

Alternative 2 would be identical to the proposed Project with regards to Criterion GEO2, therefore construction and operation of Alternative 2 is not expected to interfere with access to these resources. No impact would occur.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

The mid-slope portion of Alternative 2 crosses several existing landslides and is underlain by the landside prone Pelona Schist and excavation and grading during construction could result in slope instability (Impact G-1), a significant impact. Additionally, this portion of the Alternative 2 alignment would cross previously undisturbed slopes, and would require significant grading to construct access roads and work areas in soil units with sever potential for erosion, which could result in excessive wind and water erosion (Impact G-2), a significant impact. If helicopters are used for this portion of Alternative 2, potential soil disturbance and thus erosion would be less, however some erosion potential would still exist from grading required to construct the tower foundations. Implementation of Mitigation Measure G-1 (Protect Against Slope Instability) and Mitigation Measure G-2 (Minimization of Soil Erosion) prior to Project design would ensure that both Impacts G-1 and G-2 would be reduced to a less-than-significant level for this alternative (**Class II**).

Substantial Alteration of Topography (Criterion GEO4)

Impact G-14: Grading of New Access Roads would Permanently Alter Topography

Ground disturbance along Alternative 2 would be approximately 116.7 acres and would include shallow grading for access roads and work areas and excavations for the tower footing areas and within the substations for foundations. This alternative would also require fairly significant grading and potential cut and fill to construct new spur roads along the eastern slope below Del Sur Ridge to reach those towers that would not be installed by helicopter (of the 56 towers located mid-slope 37 towers would be constructed by helicopter). The total acreage of ground disturbance (temporary and permanent) associated with Alternative 2 is less than either the proposed Project (approximately 121 acres), the overhead portions of Alternative 1 (approximately 128.7 acres), or Alternatives 3, 4, or 5 (121.8 acres, 125.5 acres, and 145.6 acres, respectively). Additionally, with the exception of Alternative 5, Alternative 2 would result in the least amount of disturbance due to the construction of new spur roads on USFS lands. However, the eastern slope of Del Sur Ridge is more susceptible to wind and water erosion in comparison to the alignments of the proposed Project and other alternatives due to its exposed face and gradient, and temporary and permanent disturbances to it would result in a greater potential to increase or exacerbate erosion due to wind and surface water runoff. Consequently, the Del Sur Ridge mid-slope segment of Alternative 2 that is not ~~The significant alteration of topography along the slope below Del Sur Ridge Road caused by construction of new spur roads to towers located mid-slope, which are not~~ constructed by helicopter would result in a significant impact. However, implementation of Mitigation Measure G-2 (Minimization of Soil Erosion) during construction, and Mitigation Measure B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) following construction would reduce potential impacts ~~of substantial changes in topography~~ due to grading ~~for Alternative 2~~ and cut and fill to a less-than-significant level (**Class II**).

Earthquake-Related Ground Rupture (Criterion GEO5)

As with the proposed Project, Alternative 2 would be subject to hazards of substantial surface fault rupture and offset at overhead crossings of active traces of the San Andreas Fault and of the San Gabriel Fault, and fault rupture hazards would be less where the overhead portion of the alternative crosses the trace of the potentially active Clearwater Fault (Impact G-4). This would be a significant impact. Implementation of Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) prior to construction would reduce impacts associated with overhead active fault crossings to less-than-significant levels (**Class II**).

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

This alternative would have similar potential for liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route as the proposed Project. However, the portion of Alternative 2 that differs from the proposed Project alignment is located mid-slope in an area underlain by landslide prone Pelona Schist and crosses several existing landslides, resulting in an increased potential for seismically induced landslides. These phenomena could cause damage to proposed Project structures (Impact G-5). Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability) prior to construction would reduce potentially significant impacts for all potential instances of seismically related ground failure for this alternative to less-than-significant levels (**Class II**).

As with the proposed Project, Alternative 2 would be subject to moderate to severe groundshaking from any of the major faults in the region, which could also result in damage to Project structures (Impact G-6), a significant impact. Implementation of Mitigation Measure G-6 (Reduce Effects of Groundshaking) prior to construction would reduce potential impacts to less-than-significant levels (**Class II**).

Damage to Project structures from Unsuitable soils (Criterion GEO7)

The potential impacts from corrosive and other problematic soils (Impacts G-7 and G-8, respectively) along this alternative are the same as for the proposed Project and would be significant. Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) would reduce Impact G-7 to a less-than-significant level (**Class II**). Application of Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils) for Impact G-8 prior to construction would reduce potential impacts from unsuitable soils to a less-than-significant level (**Class II**).

Damage to Transmission Line Support Structures from Landslides (Criterion GEO9)

As with the proposed Project, much of the Alternative 2 alignment crosses hillside areas underlain by landslide prone geologic units and is crossed by several small existing landslides. This alignment, however, crosses more existing landslides within the landslide prone Pelona Schist, and may be more susceptible to future landslides in this area. Landslides, earth flows, and debris flows could potentially cause damage to Project structures (Impact G-9), a significant impact. Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to Project construction.

Directly or indirectly destroy a unique paleontological resource (Criterion 10)

Alternative 2 crosses the same fossil-bearing geologic formations as the proposed Project along the same alignment as the proposed Project, which results in the same potential for damage to or destruction of significant fossils (Impact G-10) as the proposed Project, a significant impact. Implementation of Mitigation Measure G-10 (Protection of Paleontological Resources) would reduce any impact to paleontologic resources to less-than-significant levels (**Class II**).

C.5.8 Alternative 3: Antelope-Pardee Single-Circuit 500-kV Towers between Haskell Canyon and Pardee Substation

The Alternative 3 alignment is identical to the proposed Project. This alternative only differs in that between Mile 20.3 and Mile 25.6 single-circuit 500-kV towers would be constructed instead of constructing double-circuit 500-kV towers and removing the existing single-circuit 500-kV towers.

C.5.8.1 Affected Environment

As Alternative 3 follows the same alignment as the proposed Project and results in the same amount of ground disturbance, the geologic, seismic, and paleontologic setting for Alternative 3 is identical to the setting for the proposed Project and is presented in Sections C.5.1.1 to C.5.1.4.

C.5.8.2 Impacts and Mitigation Measures

The geologic, seismic, and paleontologic impacts of Alternative 3 are discussed below under subheadings corresponding to each of the significance criterion presented in Section C.5.3.

Unique Geologic Features (Criterion GEO1)

Alternative 3 would be identical to the proposed Project with regards to Criterion GEO1. No unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected, resulting in no impact from construction of this Alternative.

Known Mineral and/or Energy Resources (Criterion GEO2)

Alternative 3 would be identical to the proposed Project with regards to Criterion GEO2, therefore construction and operation of Alternative 3 is not expected to interfere with access to these resources. No impact would occur.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

Because Alternative 3 follows the same alignment as the proposed Project route, impacts with regards to Criterion GEO3 would be identical to the proposed Project, as described in Section C.5.5.1. As with the proposed Project, excavation and grading during construction could result in slope instability (Impact G-1) and could loosen soil and cause excessive erosion (Impact G-2), which would be significant impacts. Implementation of Mitigation Measure G-1 (Protect Against Slope Instability) would reduce Impact G-1 for this alternative to a less-then-significant level (**Class II**), and implementation of Mitigation Measure G-2 (Minimization of Soil Erosion) prior to construction would reduce Impact G-2 for this alternative to less-than-significant levels (**Class II**). Furthermore, Application of Mitigation Measure V-4a (Construct, Operate, and Maintain with Helicopters - see Section C.15, Visual Resources) would reduce the number of miles of access and spur roads that would be constructed or improved on NFS lands and would and therefore the amount of potential erosion.

Substantial Alteration of Topography (Criterion GEO4)

Impacts of Alternative 3 would be identical to the proposed Project with regards to Criterion GEO4, with only limited shallow grading for access roads and work areas and excavations limited to the tower footing areas and within the substations for foundations. Therefore, substantial alteration of the topography is not anticipated, however minor changes to topography will occur. The minor changes in topography (Impact G-3) anticipated due to grading of work areas and new access roads are a less than significant impact (**Class III**). Although this impact is less than significant, the implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) would substantially reduce the effects of minor changes in topography due to grading for the project.

Earthquake-Related Ground Rupture (Criterion GEO5)

Alternative 3 follows the same alignment as the proposed Project and would be subject to the same hazards of substantial surface fault rupture and offset at the crossings of active traces of the San Andreas Fault and of the San Gabriel Fault, and lesser fault rupture hazards where the alternative crosses the trace of the potentially active Clearwater Fault (Impact G-4), a significant impact. Implementation of Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) prior to construction reduces impacts associated with overhead active fault crossings to less-than-significant levels (**Class II**).

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

This alternative would have the same potential for seismically induced landslides, liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route as the proposed Project. These phenomena could cause damage to proposed Project structures (Impact G-5), a significant impact. Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability) prior to construction would reduce potentially significant impacts for all potential instances of seismically related ground failure for this alternative to less-than-significant levels (**Class II**).

Alternative 3 would be subject to the same moderate to severe groundshaking from major faults in the region as the proposed Project, which could also result in damage to Project structures (Impact G-6), a significant impact. To reduce potential impacts to less-than-significant levels (**Class II**), Mitigation Measure G-6 (Reduce Effects of Groundshaking) shall be implemented prior to construction.

Damage to Project structures from Unsuitable soils (Criterion GEO7)

The potential impacts from corrosive and other problematic soils (Impacts G-7 and G-8, respectively) along Alternative 3 are the same as for the proposed Project and would be significant. Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) for Impact G-7 and Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils) for Impact G-8 prior to construction would reduce potential impacts from unsuitable soils to less-than-significant levels (**Class II**).

Damage to Transmission Line Support Structures from Landslides (Criterion GEO9)

As with the proposed Project, much of the Alternative 3 alignment crosses hillside areas underlain by landslide prone geologic units and is crossed by several small existing landslides. Landslides, earth flows, and debris flows could potentially cause damage to Project structures (Impact G-9), a significant impact. Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to Project construction.

Directly or indirectly destroy a unique paleontological resource (Criterion 10)

Alternative 3 crosses the same fossil-bearing geologic formations as the proposed Project along the same alignment as the proposed Project, which results in the same potential for damage to or destruction of significant fossils (Impact G-10) as the proposed Project. Implementation of Mitigation Measure G-10 (Protection of Paleontological Resources) would reduce Impact G-10 to less-than-significant levels (**Class II**).

C.5.9 Alternative 4: Antelope-Pardee Re-Routing of New Right-of-Way along Haskell Canyon

This section discusses geologic, seismic, and paleontologic setting for the portions of Alternative 4 that deviate from the proposed Project route. The Alternative 4 route is identical to the proposed Project route, except between Mile 17.5 and Mile 20.3, where the transmission line would remain east of the proposed route to avoid the Veluzat Motion Picture Ranch and planned development in this area.

C.5.9.1 Affected Environment

Physiography

The physiographic setting of Alternative 4 is the same as the proposed Project alignment and is discussed in Section C.5.1.1.

Geologic Setting

The general geologic setting of Alternative 4 is the same as the proposed Project. Geologic conditions along the portion of Alternative 4 where it diverges from the proposed alignment are summarized in Table C.5-13. Descriptions of geologic units in the Project area are based on published geologic quadrangle maps by Thomas Dibblee (1996c).

Table C.5-13. Geologic Units along Alternative 4

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
0-17.5	Same as proposed Project alignment Mile 0-17.5			
17.5-19.7	Mint Canyon Fm	middle Miocene	Moderately indurated terrestrial fluviatile, predominantly sandstone; identified landslide hazard potential; liquefaction potential in alluvial areas	Moderate
19.7-20.6	Castaic Fm	late Miocene	Clastic marine sediments, claystone w/ lesser sandstone; identified landslide hazard potential	Moderate
20.6-25.9	Same as Proposed Project Route from Project Mile 20.3-25.6			

Notes: 1) Mile markers for alternative are based on length of entire alternative from Antelope to Pardee Substation.
2) Excavation characteristics are very generally defined as "easy," "moderate," or "difficult" based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Slope Stability

Although Alternative 4 does not cross any mapped landslides, it does cross very near to mapped landslides in the Mint Canyon and Castaic Formations. Other small landslides are also mapped in the vicinity of the alignment within these units (Dibblee, 1996c). Areas with unmapped landslides and areas of localized slope instability may also be encountered along the hills traversed by the alignment.

Soils

Soil mapping by the USDA National Resource Conservation Service (NRCS) has provided information for surface and near-surface subsurface soil materials. The Alternative 4 alignment traverses areas included in the NRCS Angeles National Forest Area and Antelope Valley Area soil surveys, and a summary of the significant characteristics of the major soil units traversed by the portion of Alternative 4 that differs from the proposed Project is presented in Table C.5-14. These soil units are presented in approximate order of first significant occurrence along the alignment, each unit may occur numerous times and at several locations along the alignment.

Table C.5-14. Major Soils along the Alternative 4 Route

Soil Name	Description	Hazard of Erosion on Roads and Trails[1, 2]	Risk of Corrosion	
			Uncoated Steel	Concrete
Angeles National Forest				
Calcixerollic Xerochrepts-Calleguas	Clay loam with some silty loam on 30 to 60 percent slopes	Severe	NA	NA
South of ANF				
Saugus	Loam on 30-50 percent slopes	Severe	Low	Low

1) Data related to hazard of erosion on roads and trails from the Hazard of Erosion and Suitability for Roads on ForestlandTable from the USDA NRCS online tabular data for the Antelope Valley (data version 1, 3/2004) and Angeles National Forest Area (data version 1, 12/2004) soil surveys.
2) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.

~~Table Notes: 1) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and that major erosion control measures are needed.~~

Mineral Resources

No active production/quarrying operations are located near the alignment and therefore there should be no impact from this alignment on mineral resources (CDMG, 1999).

Faults and Seismicity

Because the portion of Alternative 4 that differs from the proposed Project alignment and the proposed Project alignment are geographically close and located on similar terrain, the seismic setting, including regional faulting, strong groundshaking, fault rupture, liquefaction, and seismic slope stability, for Alternative 4 are similar to that of the proposed Project route. The sections below discuss the seismic setting along the segments of Alternative 2 that differ from the proposed Project

Figure C.5-2 shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults that represent significant potential seismic sources are presented in Table C.5-3.

Strong Groundshaking

GIS data based on the CGS Probabilistic Seismic Hazard Assessment (PSHA) Maps was used to estimate peak ground accelerations along the underground segments of Alternative 4. The portion of Alternative 4 that deviates from the proposed route has a peak ground acceleration (PGA) value of 0.4 to 0.5g for its entire length (approximately 3 miles) which is the same as the equivalent section of the proposed Project alignment.

Fault Rupture

Alternative 4 does not cross any active or potentially active fault traces along the segment that diverges from the proposed Project route.

Liquefaction

The Alternative 4 alignment along the segment that diverges from the proposed Project route is not underlain by any potentially liquefiable materials.

Seismic Slope Instability

The Mint Canyon and Castaic Formations that underlie Alternative 4 are prone to landslides and will likely be susceptible to seismically induced landsliding in areas with moderate to steep slopes and previously existing landslides. CGS seismic hazard mapping has not been conducted for this area (the Mint Canyon Quadrangle).

Paleontology

Alternative 4 is underlain primarily by Mint Canyon and Castaic Formations, which are highly sensitive units paleontologically and may contain significant fossils. Significant fossils that could be encountered in the Mint Canyon Formation include those of turtles, rabbits, dogs, pronghorn antelope, camel, and three genera of fossil horses and the middle to late Miocene Castaic Formation is known to contain camel and rare tapir fossils in the project vicinity (Hurlburt, 2004~~6~~).

C.5.9.2 Impacts and Mitigation Measures

The geologic, seismic, and paleontologic impacts of Alternative 4 are discussed below under subheadings corresponding to each of the significance criterion presented in Section C.5.3.

Unique Geologic Features (Criterion GEO1)

As with the proposed Project, no unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by construction of Alternative 4. No impact would occur.

Known Mineral and/or Energy Resources (Criterion GEO2)

Alternative 4 would be identical to the proposed Project with regards to Criterion GEO2, therefore construction and operation of Alternative 4 is not expected to interfere with access to these resources. No impact would occur.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

Impacts related to criterion GEO3 would be the same as the proposed Project consisting of slope instability (Impact G-1) due to excavation and grading during construction on slopes underlain by the landslide prone Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation, resulting in a significant impact. Additionally, excavation and grading could loosen soil or remove stabilizing vegetation and expose areas of loose soil to increased soil loss and erosion by wind and stormwater runoff (Impact G-2). Portions of Alternative 4 cross areas underlain by soils classified as having moderate to severe hazard of erosion on roads and trails. Implementation of Mitigation Measure G-1 (Protect Against Slope Instability) and Mitigation Measure G-2 (Minimization of Soil Erosion) prior to construction would reduce Impacts G-1 and G-2 for this alternative to less-than-significant levels (**Class II**). Furthermore, Application of Mitigation Measure

V-4a (Construct, Operate, and Maintain with Helicopters - see Section C.15, Visual Resources) would reduce the number of miles of access and spur roads that would be constructed or improved on NFS lands and would and therefore the amount of potential erosion.

Substantial Alteration of Topography (Criterion GEO4)

Ground disturbance along Alternative 4, approximately 125.5 acres, would be limited shallow grading for access roads and work areas and excavations would be limited to the tower footing areas and within the substations for foundations Although this is slightly higher than the estimated ground disturbance for the proposed Project (approximately 121.8 acres) the general character of surface alteration is the same. Therefore, substantial alteration of the topography is not anticipated, however minor changes to topography will occur. The minor changes in topography (Impact G-3) anticipated due to grading of work areas and new access roads are a less than significant impact (**Class III**). Although this impact is less than significant, the implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) would substantially reduce the effects of minor changes in topography due to grading for the project.

Earthquake-Related Ground Rupture (Criterion GEO5)

As with the proposed Project, Alternative 4 would be subject to hazards of substantial surface fault rupture and offset at overhead crossings of active traces of the San Andreas Fault and of the San Gabriel Fault, and lesser fault rupture hazards where the overhead portion of the alternative crosses the trace of the potentially active Clearwater Fault (Impact G-4), a significant impact. Implementation of Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) prior to construction reduces impacts associated with overhead active fault crossings to less-than-significant levels (**Class II**).

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

Alternative 4 would have the same potential for seismically induced landslides, liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the transmission line route as the proposed Project. These phenomena could cause damage to proposed Project structures (Impact G-5), a significant impact. Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability) prior to construction would reduce potentially significant impacts for all potential instances of seismically related ground failure for this alternative to less-than-significant levels (**Class II**).

Alternative 4 would be subject to the same moderate to severe groundshaking from the same major faults in the region as the proposed Project, which could also result in damage to Project structures (Impact G-6), a significant impact. To reduce potential impacts to less-than-significant levels (**Class II**), Mitigation Measure G-6 (Reduce Effects of Groundshaking) shall be implemented prior to construction.

Damage to Project structures from Unsuitable soils (Criterion GEO7)

The impacts from corrosive and other problematic soils (Impacts G-7 and G-8, respectively) along Alternative 4 are the same as for the proposed Project and would be significant. Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) for Impact G-7, and application of standard design and construction practices and implementation of Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils) for Impact G-8 prior to construction would reduce potential impacts from unsuitable soils to less-than-significant levels (**Class II**).

Damage to Transmission Line Support Structures from Landslides (Criterion GEO9)

As with the proposed Project, much of the Alternative 4 alignment crosses hillside areas underlain by landslide prone geologic units and is crossed by several small existing landslides. Landslides, earth flows, and debris flows could potentially cause damage to Project structures (Impact G-9), a significant impact. Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to Project construction.

Directly or indirectly destroy a unique paleontological resource (Criterion 10)

Alternative 4 crosses the same fossil-bearing geologic formations as the proposed Project, which results in a the same potential for damage to or destruction of significant fossils (Impact G-10) as the proposed Project. Implementation of Mitigation Measure G-10 (Protection of Paleontological Resources) would reduce Impact G-10 to less-than-significant levels (**Class II**).

C.5.10 Alternative 5: Antelope-Pardee Sierra-Pelona Re-Route

This section describes the geologic and seismic hazards, and paleontology along Alternative 5 where it deviates from the proposed Project. Alternative 5 traverses south from the Antelope Substation, across the Sierra Highway and the Antelope Valley Freeway, then turns west and enters the existing Pardee-Vincent corridor, and continues west to the Pardee Substation. Alternative 5 deviates from the proposed Project from the Antelope Substation (Mile 0.0) to Alternative 5 Mile 31.9 (Project Mile 20.3), at which point the alternative alignment rejoins the proposed Project route.

C.5.10.1 Affected Environment

Physiography

The general physiographic setting of Alternative 5 is the same as the proposed Project alignment and is discussed in Section C.5.1.1.

Elevations along the Alternative 5 alignment range from about 1060 feet at the Pardee Substation to approximately 5000 feet above mean sea level (msl) in the Sierra Pelona Mountains where the alignment crosses near Mount McDill. The Antelope Substation is located at an elevation approximately 2470 feet above msl. Elevations were determined using USGS 7½ minute quadrangles from 3-D TopoQuads software (Delorme, 1999).

Geologic Setting

The general geologic setting of Alternative 5 is the same as the proposed Project. Geologic conditions along the portion of Alternative 5 that are different from the proposed Project alignment are summarized in Table C.5-15. Descriptions of geologic units along Alternative 5 are based on published geologic quadrangle maps by Thomas Dibblee (1996a, b; 1997a, b; 2002).

Table C.5-15. Geology along Alternative 5

Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
Antelope Valley and Foothills				
0-2.7	Alluvium	Holocene	Antelope Substation at MP 0; Alluvial gravel, sand, and silt	Easy
2.5	Hitchbrook Fault	Holocene	Branch fault of the San Andreas Fault Zone; minor fault rupture hazard, this branch not currently considered active	Not Applicable
2.7-4.1	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist of Portal Ridge, Identified landslide potential	Difficult
4.1-4.2	Alluvium	Holocene	Alluvial sand and clay in bottom of small valley drainage	Easy
San Andreas Rift Zone				
4.2-4.3	Alluvium	Holocene	Identified liquefaction potential	Easy
4.3-4.7	San Andreas Fault Rift Zone	Recent and Holocene	Rift zone of San Andreas Fault; significant fault rupture hazard	Not Applicable
4.3-4.6	Anaverde Fm	Pliocene	Anaverde Formation (sandstone, shale, and breccia) and quartz diorite; identified landslide hazard potential	Easy
4.6-4.8	Alluvium	Holocene	Identified liquefaction potential	Easy
4.8	San Andreas Fault	Recent & Holocene	Concealed strand of the San Andreas Fault	Not Applicable
Sierra Pelona Uplift				
4.8-5.2	Older Alluvium	Pleistocene	Sand and gravel alluvial fan deposits, derived primarily from granitic sources.	Easy
5.2-6.2	Quartz Diorite-Gneiss Complex	Late Mesozoic and older	Granitic rocks with some gray gneiss, variable weathering profile, possible landslide hazard potential	Difficult
6.2-6.3	Alluvium	Holocene	Alluvial gravel, sand, and silt.	Easy
6.3-6.6	Quartz Diorite-Gneiss Complex	Late Mesozoic and older	Granitic rocks with some gray gneiss, variable weathering profile, possible landslide hazard potential	Difficult
6.6-8.4	Quartz Diorite-Gneiss Complex	Late Mesozoic and older	Granitic rocks with some gray gneiss, variable weathering profile, possible landslide hazard potential	Difficult
8.4-8.6	Alluvium	Holocene	Alluvial gravel, sand, and silt.	Easy
8.6-9.0	Quartz Diorite-Gneiss Complex	Late Mesozoic and older	Granitic rocks with some gray gneiss, variable weathering profile, possible landslide hazard potential	Difficult
9.0-9.3	Alluvium	Holocene	Alluvial gravel, sand, and silt.	Easy
9.1	San Francisquito Fault	Pre-Quaternary	Likely inactive, no significant fault rupture hazard	Not Applicable
9.3-12.8	Pelona Schist	Unknown, assumed late Miocene or older	Mica schist, out-of-slope dipping foliation; landslide hazard potential	Difficult
9.8	Landslide	Recent	Long narrow landslide in foliated metamorphic rock	Difficult
11.2-11.3	Landslide	Recent	Small landslide in foliated metamorphic rock	Difficult
Soledad Basin				
12.8-13.7	Older Alluvium	Pleistocene	Sand and gravel alluvial fan deposits, derived primarily from schists. Small amounts of alluvium near the center of side drainages.	Easy
13.7-14.1	Alluvium	Recent	Alluvial sand, gravel, and silt along Agua Dulce Canyon.	Easy
14.1-14.8	Granitic Rocks	Late Mesozoic and older	Granitic rocks ranging from quartz monzonite to granite. Some areas with diorite.	Difficult
14.8-15.3	Older Alluvium	Pleistocene	Sand and gravel alluvial fan deposits, derived primarily from granitic sources. Small amounts of alluvium near the center of side drainages.	Easy
15.3-16.2	Syenite	Precambrian	Granitic rocks consisting of syenite composed mostly of feldspars.	Difficult
16.2-22.2	Vasquez Fm	early Miocene to Oligocene	Terrestrial sedimentary deposits with andesitic to basaltic volcanic flows and flow-breccias. Sedimentary units along the alignment consist of hard, cemented sandstone and conglomerate.	Difficult
22.2-22.9	Tick Canyon Fm	early Miocene	Poorly consolidated, conglomeratic sandstone (fanglomerate) and lesser pinkish brown sandstone, siltstone, and reddish claystone of fluvial origin with interlayered lake beds.	Moderate
22.9-29.3	Mint Canyon Fm	middle Miocene	Lacustrine and fluvial sedimentary rocks consisting primarily of sandstone and conglomeratic sandstone, with lesser interbeds of claystone, siltstone, silty sandstone, and minor limestone and tuff beds. Identified landslide hazard potential.	Moderate
28.8-29.0	Landslide	Recent	Small landslide on slope with out-of-slope dipping beds.	Moderate

Table C.5-15. Geology along Alternative 5				
Mile Marker[1]	Formation/ Feature Name	Geologic Age of Formation/ Feature	Description/Comments	Excavation Characteristics[2]
29.3-30.4	Alluvium	Recent	Alluvial sand, gravel, and clay on the floor of Bouquet Canyon. Liquefaction hazard potential.	Easy
30.4-31.4	Mint Canyon Formation and Alluvium	middle Miocene Recent	Interbedded sedimentary units of Mint Canyon Fm on ridges and hills, and Alluvial gravel, sand, and clay in side drainage and canyons floors.	Moderate to Easy
31.4-31.9	Castaic Fm	late Miocene	Clastic marine sediments, claystone w/ lesser sandstone; identified landslide hazard potential	Moderate
At Alternative 5 Mile 31.9 the alignment joins the proposed Project alignment (Mile 20.3) and geology from this point is described in Table C.5-1.				

Notes: 1) Mile markers for alternative are based on length of entire alternative from Antelope to Pardee Substation.
2) Excavation characteristics are very generally defined as "easy," "moderate," or "difficult" based on increasing hardness of the rock unit. Excavation characteristic descriptions are general in nature and the actual ease of excavation may vary widely depending on site-specific subsurface conditions.

Slope Stability

Although most of Alternative 5 does not cross areas identified as an existing landslide, several moderate to small landslides are mapped along the alignment. Additionally, numerous landslides have been mapped in the vicinity within geologic units traversed by the alignment: the Pelona Schist, the Mint Canyon Formation, the Castaic Formation, and the Saugus Formation (Dibblee, 1996a, b; 1997b; 2002; and CGS, 1997; 1998a; 2003c, d). Unmapped landslides and areas of localized slope instability may be encountered in the hills traversed by the alignment.

Soils

Soil mapping by the USDA National Resource Conservation Service (NRCS) has provided information for surface and near-surface subsurface soil materials. The Alternative 5 alignment traverses areas included in the NRCS Antelope Valley soil survey. Alternative 5 traverse numerous soil types, a summary of the significant characteristics of the major soil units traversed by Alternative 5, up to the intersection with the proposed Project alignment, is presented in Table C.5-16. These soil units are presented in approximate order of first significant occurrence along the alignment, each unit may occur numerous times and at several locations along the alignment.

Table C.5-16. Major Soils along Alternative 5				
Soil Name	Description	Hazard of Erosion on Roads and Trails[1,2]	Risk of Corrosion	
			Uncoated Steel	Concrete
Greenfield	Sandy Loam on 2-9 percent slopes	Moderate	Low	Low
Hanford	Sandy to coarse sandy loam on 5 to 9 percent slopes, and gravelly sandy loam on 2 to 9 percent and 9 to 30 percent slopes	Moderate	Low	Low
Vista	Coarse sandy loam on 30-50 percent slopes, eroded in areas	Severe	Low	Low
Ramona	Coarse sandy loam on 2-5 and 5-9 percent slopes; and sandy loam on 9 to 30 percent slopes	Moderate to Severe	Moderate	Moderate
Amargosa	Rocky coarse sandy loam on 9-55 percent slopes	Severe	Moderate	Low
Anaverde	Loam on 15 to 30 percent slopes and rocky loam on 30 to 50 percent slopes	Severe	Moderate	Low

Table C.5-16. Major Soils along Alternative 5

Soil Name	Description	Hazard of Erosion on Roads and Trails[1,2]	Risk of Corrosion	
			Uncoated Steel	Concrete
Goode	Loam on 15 to 30 percent slopes and rocky loam on 30 to 50 percent slopes	Severe	Moderate	Moderate
Wyman	Gravelly loam on 2 to 9 percent slopes	Moderate	Low	Low
Las Posas-Toomes	Rocky loam on 30 to 50 percent slope.	Severe	Low to High	Low
Ojai	Loam on 2 to 9 percent and 30 to 50 percent slopes	Moderate	Moderate	Low
Millsholm	Rocky loam on 15 to 30 percent and 30 to 50 percent slopes	Severe	Low	Low
Saugus	Loam on 30-50 percent slopes	Severe	Low	Low
Castaic-Balcom	Silty clay loam on 30 to 50 percent slope	Severe	High	Low

1) Data related to hazard of erosion on roads and trails from the Hazard of Erosion and Suitability for Roads on Forestland Table from the USDA NRCS online tabular data for the Antelope Valley (data version 1, 3/2004) and Angeles National Forest Area (data version 1, 12/2004) soil surveys.
2) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.

~~Table Notes: (1) Erosion Hazard: Slight – little or no erosion is likely, Moderate – some erosion is likely and that simple erosion control measures are needed, Severe – significant erosion is expected and major erosion control measures may be needed.~~

Mineral Resources

The Alternative 5 alignment traverses areas identified as sand and gravel resources by the State Mining and Geology Board in the Santa Clara River valley, however no active production/quarrying operations are located near the alignment (CDMG 1987, 1999).

Faults and Seismicity

The regional seismic setting for Alternative 5 is the same as for the proposed Project; therefore the general descriptions of regional faulting, strong groundshaking, fault rupture, liquefaction, and seismic slope stability for Alternative 5 are that the same as the proposed Project route. However, as most of the Alternative 5 alignment is located east of the proposed Project alignment, local seismic hazards are slightly different than along the proposed Project alignment. The only notable difference in seismic setting is that faults located southeast of the Project area are minimally closer to the Alternative 5 alignment, approximately 4-5 miles closer, than to the proposed Project alignment.

Figure C.5-2 shows locations of active and potentially active faults (representing possible seismic sources) and earthquakes in the region surrounding the Project area. Active and potentially active faults that represent significant potential seismic sources are presented in Table C.5-3.

Strong Groundshaking

GIS data based on the CGS Probabilistic Seismic Hazard Assessment (PSHA) Maps was used to estimate peak ground accelerations along the Alternative 5. PSHA Maps depict peak ground accelerations with a 10 percent probability of exceedance in 50 years. The results for Alternative 5 are presented in Table C.5-17.

Table C.5-17. Peak Ground Acceleration along Alternative 5

Approximate Alternative Transmission Line Mile[1]	Total Length of Segments (miles)	Peak Ground Acceleration
Alternative 5		
6.6 to 10.1	3.5	0.4 to 0.5g
1.2 to 3.4 and 10.1 to 14.1	6.2	0.5 to 0.6g
0 to 1.2, 3.4 to 3.8, and 14.1 to 20.7	8.2	0.6 to 0.7g
3.8 to 6.6 and 20.7 to 31.9	14.0	0.7 to 0.8g

(1) Mile locations are measured from Antelope Substation.

Fault Rupture

The Alternative 5 alignment crosses the San Andreas Fault Zone south of the proposed Project fault zone crossing. The San Andreas Fault Zone is mapped as an Alquist-Priolo zone at the Alternative 5 crossing. The limits of this zone in the vicinity of Alternative 5 are presented on Figure C.5-3.

Fault rupture has occurred historically within this area; the 1857 Fort Tejon Earthquake caused rupture of the local strands of the San Andreas Fault.

Liquefaction

Surface materials beneath the proposed alignment meet the criteria for liquefaction in the young alluvial deposits in the Santa Clara River valley, the Leona Valley, and in the alluvial and creek deposits of intervening drainages. Older and finer or coarser grained, indurated, and/or well-drained materials are less susceptible to liquefaction.

Seismic hazard mapping, delineating areas of potential liquefaction and seismically induced landslides, has been conducted by the State of California for five of the 7.5-Minute Quadrangles that the Alternative 5 alignment traverses: the Del Sur, Sleepy Valley, Agua Dulce, Mint Canyon, and Newhall Quadrangles (CGS 1998a, 1998b, 1999, 2003a, 2003b, 2004). The Alternative 5 alignment traverses mapped liquefaction hazard zones on all five maps, primarily where the alignment crosses alluvial valleys and drainages.

Seismic Slope Instability

The CGS seismic hazard maps indicate that many of the moderate to steep slopes crossed by Alternative 5 have earthquake-induced landslide potential. Local geologic units, such as the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations that are prone to landslides and that have moderate to steep slopes, and previously existing landslides, both mapped and unmapped, are particularly susceptible to earthquake-induced landslides.

Paleontology

The portion of Alternative 5 alignment that differs from the proposed Project alignment traverses late Quaternary and Tertiary geologic units that may contain significant fossils, including Older (late Quaternary) Alluvium, the Anaverde Formation, the Mint Canyon Formation, the Tick Canyon Formation, and the Castaic Formation. Portions of the alignment that are underlain by metamorphic, crystalline, or volcanic rocks have no potential for paleontological resources (Zero sensitivity). Types of fossils that may be found in the Older Alluvium (from approximately MPs 4.8 to 5.2), the Anaverde Formation (from approximately MPs 4.3 to 4.6), Mint Canyon Formation (from approximately MPs 22.8 to 29.2), and Castaic Formation (from approximately MPs 31.3 to 31.8) are discussed in Section C.5.1.4. These formations have moderate to high sensitivity. The

Tick Canyon Formation, crossed by Alternative 5 from approximately MPs 22.1 to 22.8, is also has high sensitivity. Significant fossil localities are located north of the alignment in the Tick Canyon Formation consisting of horse and camel fossils, the unit is also know to contain rabbit, kangaroo rat, and oreodont fossils (UCMP, 2006). The early Miocene to late Oligocene Vasquez Formation along the project alignment consists of interlayered sedimentary units (sandstones and conglomerates) and volcanic flows and breccias; no significant fossils have been discovered in the Vasquez Formation sedimentary units, however based on this units age and mode of deposition (on alluvial fans and flood plains) the sedimentary units of the formation are classified as having moderate sensitivity (having a strong, put unproven potential for fossils). The volcanic units have no potential for fossils.

C.5.10.2 Impacts and Mitigation Measures

The geologic, seismic, and paleontologic impacts of Alternative 5 are discussed below under subheadings corresponding to each of the significance criterion presented in Section C.5.3.

Unique Geologic Features (Criterion GEO1)

Similar to the proposed Project, no unique geologic features or geologic features of unusual scientific value for study or interpretation would be disturbed or otherwise adversely affected by construction of Alternative 5. No impact would occur.

Known Mineral and/or Energy Resources (Criterion GEO2)

Alternative 5 does not cross nor is located near any active mine or quarries and therefore construction and operation of this alternative is not expected to interfere with access to these resources. No impact would occur.

Landslides or Erosion Triggered or Accelerated by Construction (Criterion GEO3)

Alternative 5 crosses the same types of landslide prone geologic units and hilly terrain as the proposed alignment and similar to the proposed Project several small landslides are mapped along the alignment. Alternative 5 is significantly longer than the proposed Project and ~~therefore crosses a higher percentage of~~ crosses more landslide prone units along its length (20.2 miles versus 14.5 miles along the proposed Project alignment). This results in a slightly higher potential for damage from construction triggered slope failures. Therefore impacts related to slope instability (Impact G-1) due to excavation and grading during construction are a significant impact. Most of the major soils underlying the Alternative 5 alignment have a moderate to severe potential for erosion on roads and trails, and as with the proposed Project, excavation and grading for tower and substation foundations, work areas, and access roads along Alternative 5 could loosen these soils and cause excessive erosion (Impact G-2), a significant impact. Implementation of Mitigation Measure G-1 (Protect Against Slope Instability) and Mitigation Measure G-2 (Minimization of Soil Erosion) would reduce Impacts G-1 and G-2 for this alternative to less-than-significant levels (**Class II**).

Substantial Alteration of Topography (Criterion GEO4)

Under Alternative 5, approximately 150.6 acres of ground disturbance would occur during construction, including shallow grading for access roads and work areas, and excavations for the tower footing areas and within the substations for foundations. This alternative would also require more grading and potential cut and fill to construct new access roads in some areas. However, the total permanent ground disturbance for this alternative (59 acres) is only slightly higher than the estimated permanent ground disturbance for the proposed Project and Alternatives 2 and 3 (approximately 58.5, 58.0, 58.5 acres, respectively), and less than that of Alternatives 1 and 4 (Approximately 75.9 and 61.2 acres, respectively). Although Alternative 5 would require more alteration of topography during construction due to the length of the new ROW that would be needed, with the exception of Alternative 1, it would result in the greatest acreage of restored land and topography following construction (91.6 acres for Alternative 5 in comparison to 68.3, 63.7, 68.3 and 69.3 acres for the proposed Project and Alternatives 2, 3 and 4, respectively). The minor changes in topography (Impact G-3) anticipated due to grading of work areas and new access roads are a less than significant impact (**Class III**). Although this impact is less than significant, the implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) would substantially reduce the effects of minor changes in topography due to grading for the project.

shallow grading for access roads and work areas and excavations limited to the tower footing areas and within the substations for foundations, similar to the proposed Project. Therefore, substantial alteration of the topography is not anticipated along the overhead portions of the alignment, however minor changes to topography will occur. T. However, underground segments of

Ground disturbance along Alternative 5, approximately 145.6 acres would include shallow grading for access roads and work areas and excavations for the tower footing areas and within the substations for foundations. This alternative would also require fairly significant grading and potential cut and fill to construct new access roads in some areas. The ground disturbance for this alternative is higher than the estimated ground disturbance for the proposed Project (approximately 121.8 acres) and would require more alteration of topography. The significant alteration of topography that would occur for new access roads would result in a significant impact. However implementation of Mitigation Measures G-2 (Minimization of Soil Erosion) and B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities) would reduce potential impacts of substantial changes in topography due to grading for the project to less than significant (**Class II**).

Earthquake-Related Ground Rupture (Criterion GEO5)

Like the proposed Project, Alternative 5 would be subject to hazards of substantial surface fault rupture and offset at overhead crossings of active traces of the San Andreas Fault and of the San Gabriel Fault (Impact G-4), a significant impact. Implementation of Mitigation Measure G-4 (Minimize Project Structures Within Active Fault Zone) prior to final Project design reduces impacts associated with overhead active fault crossings to less-than-significant levels (**Class II**).

Damage Related to Earthquake Induced Phenomena (Criterion GEO6)

The potential for seismically induced landslides liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the Alternative 5 transmission line route the same as for the proposed Project. There is a high potential for seismically induced landslides liquefaction, settlement, lateral spreading and/or surface cracking at the substations or along the Alternative 5 transmission line route to cause damage to Project structures (Impact G-5), a significant impact. As with the proposed Project, liquefiable materials, primarily young alluvium, are present along the Alternative 5 alignment in the Leona Valley, Santa Clara River valley, and intervening drainages. There is a slightly increased potential for seismically induced landslides and other slope failures along Alternative 5, as much of the alignment (20.2 miles) is located along hillsides or ridgelines in geologic units on moderate to steep slopes that are particularly susceptible to seismic-induced ground failure in the form of landsliding or ground-cracking, units such as the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations. The increased length of power line route of Alternative 5 versus the proposed Project (20.2 vs. 14.5 miles) through landslide prone units increases the potential for seismically induced landslides and other slope failures. Implementation of Mitigation Measure G-5 (Geotechnical Investigations for Liquefaction and Slope Instability), which adds specific requirements to SCE's planned geotechnical investigations, prior to final Project design would reduce potentially significant impacts for all potential instances of seismically related ground failure along the Project to less-than-significant levels (**Class II**).

As with the proposed Project alignment, Alternative 5 would also be subject to moderate to severe groundshaking from the same major faults in the region as the proposed Project, which could result in damage to Project structures (Impact G-6), a significant impact. However due to this alignments closer proximity to many of the active regional faults, a larger portion of the alignment has estimated peak ground accelerations (PGA) of 0.6 to 0.8g. This results in a higher proportion of this alignment subject to severe groundshaking. To reduce potential impacts to less-than-significant levels (**Class II**), Mitigation Measure G-6 (Reduce Effects of Groundshaking) shall be implemented prior to construction.

Damage to Project structures from Unsuitable soils (Criterion GEO7)

This alternative is underlain by similar soils type with the same soil characteristic as the proposed Project. The potential impacts from corrosive and other problematic soils (Impacts G-7 and G-8, respectively) along Alternative 5 are the same as those for the proposed Project. Implementation of Mitigation Measure G-7 (Geotechnical Studies for Corrosive Soils) for Impact G-7, and implementation of Mitigation Measure G-8 (Geotechnical Studies for Problematic Soils) for Impact G-8 prior to construction would reduce potential impacts from unsuitable soils to less-than-significant levels (**Class II**).

Damage to Transmission Line Support Structures from Landslides (Criterion GEO9)

As with the proposed Project, much of the Alternative 5 alignment (20.2 miles) crosses hillside areas underlain by landslide prone geologic units, units such as the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations, and is crossed by existing landslides. More of this ~~uch of the~~ alignment (20.2 miles versus 14.5 miles) is located along hillsides or ridgelines in these geologic units on moderate to steep slopes that are particularly susceptible to ground failure.~~units such as the Pelona Schist, and Mint Canyon, Castaic, and Saugus Formations~~. This results in a slightly higher potential for damage to project facilities from slope failures. Landslides, earth flows, and debris flows could potentially cause damage to project structures (Impact G-9). Impacts associated with slope instability would be mitigated to less-than-significant levels (**Class II**) with implementation of Mitigation Measure G-9 (Geotechnical Surveys for Landslides) prior to project construction.

Directly or indirectly destroy a unique paleontological resource (Criterion 10)

Alternative 5 crosses the same fossil-bearing geologic formations as the proposed Project, which results in the same potential for damage to or destruction of significant fossils (Impact G-10) as the proposed Project, a significant impact. Implementation of Mitigation Measure G-10 (Protection of Paleontological Resources) would reduce Impact G-10 to less-than-significant levels (**Class II**).

C.5.11 No Project/Action Alternative

Under the No Project/Action Alternative, the proposed Project would not be implemented and, therefore, the impacts associated with the proposed Project and alternative described in Sections C.5.5 through C.5.11 above would not occur.

However, as identified in Section B.4.8.2, in the absence of the proposed Project, other actions would occur. Some wind projects would be postponed or cancelled, or alternatives developed that would meet the RPS goal by 2010. SCE would need to accommodate the power load by upgrading existing transmission infrastructure or building new transmission facilities along a different alignment. Construction methods, resulting impacts, and regulatory requirements associated with other transmission projects would be similar to those identified for the proposed Project. Therefore, any alternative project proposed by SCE would be expected to have similar impacts related to Geology, Soils, and Paleontologic Resources as the proposed Project.

C.5.12 Impact and Mitigation Summary

Table C.5-18 presents a summary of the impacts and proposed mitigation measures for geology, soils, and paleontology. Mitigation measures are listed below the impact significance classification for each alternative.

Table C.5-18. Impact and Mitigation Summary – Geology, Soils, and Paleontology

Impact	Impact Significance					
	Proposed Project	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
G-1: Excavation and grading during construction activities could cause slope instability.	Class II	Class II	Class II	Class II	Class II	Class II
	G-1	G-1	G-1	G-1	G-1	G-1
G-2: Erosion could be triggered or accelerated by construction or disturbance of landforms.	Class II	Class II	Class II	Class II	Class II	Class II
	G-2	G-2	G-2	G-2	G-2	G-2
G-3: Minor changes in topography due to excavation and grading.	Class III	Class III	Class III	Class III	Class III	Class III
	G-2 and B-1a*	G-2 and B-1a*	G-2 and B-1a*	G-2 and B-1a*	G-2 and B-1a*	G-2 and B-1a*
G-4: Transmission line damaged by surface fault ruptures at crossings of active faults.	Class II	Class II	Class II	Class II	Class II	Class II
	G-4	G-4	G-4	G-4	G-4	G-4
G-5: Project structures could be damaged by landslides, liquefaction, settlement, lateral spreading, and/or surface cracking resulting from seismic events.	Class II	Class II	Class II	Class II	Class II	Class II
	G-5	G-5	G-5	G-5	G-5	G-5
G-6: Project structures could be damaged by strong groundshaking.	Class II	Class II	Class II	Class II	Class II	Class II
	G-6	G-6	G-6	G-6	G-6	G-6
G-7: Buried tower and substation foundations could be damaged by corrosive soils.	Class II	Class II	Class II	Class II	Class II	Class II
	G-7	G-7	G-7	G-7	G-7	G-7
G-8: Tower and substation foundations could be damaged by expansive or collapsible soils.	Class II	Class II	Class II	Class II	Class II	Class II
	G-8	G-8	G-8	G-8	G-8	G-8
G-9: Transmission line structures could be damaged by landslides, earth flows, or debris slides.	Class II	Class II	Class II	Class II	Class II	Class II
	G-9	G-9	G-9	G-9	G-9	G-9
G-10: Excavation for transmission line structures could damage unique or significant fossils.	Class II	Class II	Class II	Class II	Class II	Class II
	G-10	G-10	G-10	G-10	G-10	G-10
G-11: Construction activities would interfere with access to known mineral resources.	No impact	Class II	No impact	No impact	No impact	No impact
	None	G-11	None	None	None	None
G-12: Installation of underground infrastructure would permanently alter topography.	No impact	Class II	No impact	No impact	No impact	No impact
	None	G-2 and B-1a*	None	None	None	None
G-13: Underground transmission line damaged by surface fault ruptures at crossing of active San Gabriel Fault.	No impact	Class II	No impact	No impact	No impact	No impact
	~~G-13~~None	G-13	~~G-13~~None	~~G-13~~None	~~G-13~~None	~~G-13~~None
G-14: Grading of New Access Roads would Permanently Alter Topography.	No Impact	No Impact	Class II	No Impact	No Impact	No Impact
	None	None	G-2 and B-1a*	None	None	None

Class I = Significant and unavoidable impact; **Class II** = Significant but mitigated to a less-than-significant level; **Class III** = Less-than-significant impact; **Class IV** = Beneficial impact.
* Please see Section C.3.5, Biological Resources, Proposed Project/Action, Mitigation Measure B-1a (Provide Restoration/Compensation for Impacts to Native Vegetation Communities).

C.5.13 Cumulative Effects

C.5.13.1 Geographic Extent

The geographic extent for considering cumulative impacts to Geology, Soils, and Paleontology is limited to the immediate vicinity of the ROW (designated Utility Corridor on NFS lands) which is occupied by the proposed Project and alternative alignments. The "immediate vicinity" includes the area physically within the ROW or designated Utility Corridor, as well as any area outside the ROW or designated Utility Corridor which is occupied during construction or operation of the Project for project-related uses. For instance, transition stations, marshalling yards, and spur roads that would be established and utilized for the purposes of the proposed Project or an alternative would be considered part of the cumulative analysis area. This geographic extent is appropriate for the issue area of geology, soils, and paleontology because any potential impacts of the proposed Project or an alternative would be site-specific.

C.5.13.2 Existing Cumulative Conditions

Past and ongoing development throughout northern Los Angeles County and the proposed Project area has resulted in substantial alternations to the natural landscape. The ongoing growth of communities such as Lancaster, Palmdale, and Santa Clarita, as well as unincorporated Los Angeles County, continues to transition land uses from largely open space and agricultural to residential developments. Past, existing, and future projects could contribute to the cumulative effects of geology, soils, and paleontology by creating any of the following conditions:

- Loss or restriction of access to known mineral, energy, and/or paleontological resources
- Triggering or acceleration of erosion or slope failures
- Groundshaking, earthquake-induced ground failure, and fault rupture

These conditions would be limited to the areas within and adjacent to the boundaries of individual projects. A list of cumulative projects within five miles of the proposed route is provided in Table B.5-1 (Cumulative Projects List). Most of the cumulative projects listed in Table B.5-1 are residential developments or are related to residential developments. In order for cumulative impacts to geology, soils, and paleontology, to occur, the conditions listed below would have to happen at the same time and in the same location as the same conditions for the proposed Project or alternative.

Section B.5.4 provides a discussion of past, existing, and future cumulative projects on NFS lands within the Project area. Within the ANF, land disturbance associated with cumulative projects is minimal because residential and commercial development is not allowed by the NFS. Cumulative projects on NFS lands that could potentially contribute to impacts on geology, soils, and paleontology include roadways, water projects, utility projects, and recreational facilities such as trails and campgrounds. Land modifications resulting from these projects are minimal and are not expected to contribute to cumulative effects for this environmental issue area, particularly due to the limited extent of the cumulative analysis area. In addition, it is reasonably assumed that the NFS would implement BMPs to preserve mineral, energy, and paleontological resources, to promote slope stability, and to ensure protection against seismic events.

C.5.13.3 Cumulative Impact Analysis

The discussion of cumulative projects and growth projections in the proposed Project area, which is provided in Section B.5 (Cumulative Impacts Scenario), indicates that undeveloped land south of the ANF in Santa Clarita and unincorporated Los Angeles County will be developed in the near future. Activities from other current and proposed Projects would only have potential to combine with activities of the proposed Project if they: (1) occur within the cumulative analysis area for the proposed Project and alternatives, which includes construction areas; and (2) occur at the same time as proposed Project construction. Because potential cumulative impacts on geologic conditions and paleontologic resources would be the result of concurrent, overlapping excavation activities, the potential impacts associated with proposed Project do not have the potential to combine with the impacts of other projects to result in a cumulatively considerable impact.

C.5.13.4 Cumulative Effects on National Forest System Lands

With regard to geology, soils, and paleontology, cumulative effects of the proposed Project and alternatives on NFS lands would be the same as on non-NFS lands, as described above. Because potential cumulative impacts on geologic conditions and paleontologic resources would be the result of concurrent, overlapping excavation activities, the potential impacts associated with proposed Project do not have the potential to combine with the impacts of other projects to result in a cumulatively considerable impact on NFS lands.