5.6 Geology and Soils

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

Significance criteria established by CEQA Guidelines, Appendix G.

5.6.1 Setting

Regional Setting

The proposed project is in the Coast Ranges Geomorphic Province of California, 65 miles northwest of San Francisco and 18 miles from the Pacific Ocean. Windsor is in the Santa Rosa Valley, with the Russian River and Mendocino Range to the west and the northwest-southeast trending foothills of the Mayacamas and Sonoma Mountains to the east. These mountains are comprised chiefly of three major rock groups: the Franciscan Complex, the Coast Range ophiolite, and the Great Valley Sequence. Most of the valleys and ridges in the region have formed in response to tectonic stresses related to the San Andreas Fault system. Landslides in the region have helped generate an irregular topography (PG&E 2010).

Project Setting

The substation site is approximately 120 feet above mean sea level. The topography of the substation property and the vicinity slopes gently to the west.

Geology. The geology in the vicinity of the project site consists largely of sedimentary and volcanic rocks of Holocene (less than 11,000 years in age) and Pleistocene age (2.588 million to 12,000 years before present). The Windsor Syncline, which contains deposits of the Glenn Ellen Formation and Quaternary Alluvium, forms the main trough of the Santa Rosa Valley and the project area. The Quaternary Alluvium generally underlies the flat-lying areas and waterways, with the youngest alluvial deposits surrounding stream channels and older alluvial deposits beneath the flat terrain. The young alluvial deposits are particularly susceptible to liquefaction and seismically-induced settlement. The Glen Ellen Formation consists in part of partially cemented beds and alluvial fan and piedmont deposits. The Glen Ellen Formation is underlain by the Huichica and Sonoma Volcanic Formations, with numerous active and inactive faults (PG&E 2010). The geologic units in the project area are described in more detail in Table 5.6-1.

Table 5.6-1. Geologic Units in the Project Area

Symbol	Unit Name	Age	Description
Qal	Alluvium Older (Qo) and Younger (Q)	Holocene- Pleistocene	Unconsolidated stream channel deposits, stream terrace deposits, alluvial fan deposits, and flood plain deposits composed of boulders, cobbles, gravel, and sand; Q-interbedded layers of sand, silt, clay, and gravel; Qo-fine sand, silt, and silty clay, coarse sand and gravel, with gravel more abundant near fan heads
QTge	Glenn Ellen Formation	Pleistocene – Late Pliocene	Glenn Ellen formation consists of fluvial origin clay-rich stratified deposits of poorly sorted, loosely consolidated sand, silt and gravel interbedded with minor beds of matrix-supported conglomerate with basalt, andesite and obsidian clasts and silicic tuffs
QTh	Huichica Formation	Pleistocene – Late Pliocene	Huichica Formation consists of alluvial fan and fluvial deposits of massive yellow silt and yellow and blue clay with interbedded lenses of sand, gravel, and interbedded Roblar tuff beds
Tsv (Psv)	Sonoma Volcanics	Pliocene – Miocene	The Sonoma Volcanics consist of a thick sequence of continental volcanic and volcaniclastic rocks including basalt, andesite, and rhyolite lavas interbedded with tuffs, lahar deposits, debris avalanche deposits, mudflow units, reworked tuffs, sedimentary breccia deposits derived from volcanic rocks, and lacustrine deposits
Tm (Pwg)	Wilson Grove (formerly Merced) Formation	Late Pliocene - Late Miocene	Shallow marine (brackish bay) to deep-water marine deposits of fine sand and sandstone, thin interbeds of clay and silty-clay, some lenses of gravel, and localized fossils (foraminifers, brachiopods, pelecypods, mollusks, arthropods and echinoids)
Tp (Pp)	Petaluma Formation	Late Pliocene - Late Miocene	Continental and shallow marine to brackish water deposits of clay, shale, and sandstone, conglomerate, nodular limestone and diatomite, with interbedded tuffs; Contains mammalian and ostrocod fossils of Miocene age; Lower member contains shale with nonmarine and marine microfauna (diatomites) and is prone to sliding; Middle member contains conglomerate derived from Franciscan sources; Upper member contains conglomerate derived from Monterey Group; Highly folded and faulted and interfingers with Wilson Grove Formation to the west
KJf	Franciscan Complex	Cretaceous – Jurassic	Melange with blocks of greywacke, chert, greenstone, and metamorphic rocks; Intrusive sills of diabase, gabbro, and serpentinite, glaucophane and related schists

Sources: Farrar et al. 2006; PG&E 2010; PG&E 2011.

Paleontology. The alluvial sediments in the project area are unlikely to contain any significant fossil resources. The sedimentary rocks of the Glenn Ellen and Huichica Formations have not been identified as important paleontological formations, and the underlying Sonoma Volcanics are unlikely to be encountered during site construction activities, which would generally involve only shallow ground disturbance.

The University of California Museum of Paleontology (UCMP) databases of known paleontological sites in Sonoma County were reviewed to identify the occurrence of fossils in formations related to the project site. This records search identified invertebrate fossils near the Russian River, approximately 2 to 5 miles west of the project area. These invertebrate fossils are found in the Tertiary age Wilson Grove formation (formerly Merced). Due to their typical depth and distance from the project area, such fossils are unlikely to be encountered during site activities (PG&E 2010). None of the fossil locations identified in the UCMP database occur in the vicinity of the project area. See Section 5.5 (Cultural Resources) for more analysis of possible impacts to paleontological resources.

Seismicity

The project area is in the tectonically active Coast Ranges Geomorphic Province of Northern California. The 1997 Uniform Building code (UBC) locates the entire Bay Area within Seismic Risk Zone 4, which is expected to experience maximum magnitudes and damage in the event of an earthquake.

There are three active fault zones that have the potential to affect the project: the Healdsburg-Rodgers Creek, the San Andreas, and the Maacama (PG&E 2010). The San Andreas Fault Zone is located about 19 miles southwest of Windsor and is considered to be the major seismic hazard in California. According to the Earthquake Hazard Map for Windsor, the shaking severity level at the project site is expected to be strong if a major earthquake occurs (California Geological Survey 2011). Several other active faults have the potential to cause widespread damage to the project region and are listed in Table 5.6-2. An active fault is defined by the state of California as a fault that has had surface displacement within approximately the last 11,000 years (Hart 2007).

Table 5.6-2. Major Named Faults Considered Active in Northern California

Fault[1]	Maximum Earthquake Magnitude (Mw)[2]	Slip Rate (mm/yr.)	Approximate Distance to Closest Surface Trace (miles)	Direction From Project
Healdsburg-Rodgers Creek	7.0	9.0	3	East
Maacama (South)	6.9	9.0	5	Northeast
San Andreas	8.0	24.0	19	Southwest
West Napa	6.5	1.0	32	Southeast
Concord – Green Valley	6.9	6.0	32	Southeast
Hayward (North)	6.9	9.0	42	Southeast

Source: PG&E 2010

1 - These are all strike-slip faults. A strike-slip fault is an approximately vertical fault plane where the rock on one side of the fault slides horizontally past the other.

2 - This is the maximum movement magnitude. There is a 90 percent probability that it will not be exceeded in 50 years.

Fault rupture is the displacement at the earth's surface resulting from fault movement associated with an earthquake. Earthquake Fault Zones (EFZs) have been established in accordance with the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act). The Healdsburg-Rodgers Creek, Maacama (south segment), San Andreas (North Coast South), West Napa, Concord-Green Valley, and Hayward faults are all identified by the Alquist-Priolo Act. No project components are within a designated EFZ and no mapped active fault traces are known to transverse the substation site. However, surface fault rupture is not necessarily restricted to the area within an EFZ (PG&E 2010), and the site would likely experience strong levels of shaking from an earthquake in the region (ABAG 2003; California Geological Survey 2011). Severity as high as IX (violent) on the Modified Mercalli Intensity Shaking Severity Level Scale could occur in the event of a major earthquake on the Rodgers Creek fault (ABAG 2010). Sonoma County has a 17.7 percent probability of experiencing ground shaking from at least one major earthquake (Moment Magnitude of 6.7 or greater) by 2031 (Working Group of California Earthquake Probability 2003).

Geologic Hazards

Subsidence. Human activities often are the primary cause of subsidence. Activities such as underground mining of coal, groundwater or petroleum withdrawal, and drainage of organic soils cause gradual regional lowering of land elevation. Subsidence poses a greater risk to property than to life. Though impacts related to subsidence usually consist of direct structural damage, property loss, and depreciation of land value

Slope Stability and Landsliding. In Sonoma County, the frequency of fractured rock formations, steep topography, coastline geography, and regional seismicity mean that large areas are subject to slope instability and landsliding, the most widespread type of ground failure in Sonoma County (Sonoma County 2006). The project area is relatively flat and should not be vulnerable to slope instability or landslides.

Settlement. Settlement is the depression of soil when a load, such as that of a building or new fill material, is placed upon it. During an earthquake, settlement can be accelerated as a result of the relatively rapid rearrangement and compaction of subsurface materials (particularly loose, non-compacted, and variable sandy sediments). Areas susceptible to earthquake-induced settlement include those underlain by thick layers of colluvial material or unengineered fill. Soils developing on formational materials, such as the Glenn Ellen Formation, may possess a low to moderate potential for settlement (PG&E 2010).

Liquefaction. Liquefaction is the transformation of subsurface soils into a liquid state. Soil liquefaction causes ground failure that can damage roads and buildings with shallow foundations. Liquefaction is most likely to occur in areas with shallow groundwater (40 feet below ground surface or less) and low density, fine-grained sandy soils. High-intensity ground motion, like that caused by an earthquake, in these areas can lead to liquefaction (PG&E 2010). In alluvial basins within Sonoma County, the potential for liquefaction failures increases in the winter and spring when the ground water table is higher (PG&E 2010). According to the Liquefaction Hazard Map for Windsor, the project area is within an area of very low liquefaction hazard (ABAG 2001).

Expansive Soils. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of alternate wetting and drying. Expansive soils possess a "shrink-swell" characteristic, presenting a risk of structural damage over time if foundations are not properly engineered to account for soil volume change.

Soils

The proposed substation site is located on relatively flat ground with dominant soils belonging to the Haire and Huichica Series. The main soil types in the vicinity of the proposed substation site are Haire Clay Loam HcC and Huichica loam (shallow) HvC. Haire Clay Loam HcC is an alluvium derived from sedimentary rock. It is characterized by slopes ranging from 0 to 9 percent, moderate drainage, and a moderately low to moderately high capacity to transmit water. The Huichica loam (shallow) HvC is an alluvium derived from igneous, metamorphic, and sedimentary rock. It is characterized by slopes ranging from 0 to 9 percent, moderate drainage, and a very low to moderately low capacity to transmit water (NRCS 2011).

Certain soil characteristics, such as low permeability, susceptibility to expansion, and soil erosion, may limit development or create problems for existing structures. The Natural Resources Conservation Service (NRCS) land capability classification system rates soils by various characteristics dependent on location, slope, parent rock, climate, and drainage. The Haire Series is classified as a Class 3e soil, with low permeability, moderate to high shrink-swell potential, moderate-high corrosivity, and medium compressibility. The Huichica Series is classified as a Class 4e soil, with low permeability, low to high shrink-swell potential, high corrosivity, and medium compressibility (NRCS 2011). Soils categorized as Class 3 and above have limitations that make them unsuitable for cultivation, and require conservation practices and careful management during construction. Table 5.6-3 shows the properties of the soils at the proposed substation site.

Table 5.6-3. Properties of Soils at the Proposed Substation Site

Property	Huichaca Loam Shallow (HvC)	Haire Clay Loam (HcC)
Substation Parcel Coverage	86.6%	13.4%
Substation Footprint Coverage	98.8%	1.2%
Gravel Source	Poor	Poor
Sand Source	Poor	Poor
Farmland Category	Not Prime Farmland	Farmland of Statewide Importance
Erosion Factor	Moderate (K-factor = 0.37)*	Moderate (K-factor = 0.32)*
Slope	0 to 9 percent	0 to 9 percent
Shrink/Swell Potential	Low to High	Moderate to High

Source: NRCS 2011
*K-factor indicates the susceptibility of a soil to sheet and rill erosion by water. Values range from 0.02 to 0.69 with the higher value more susceptible to erosion.

Regulatory Setting

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

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

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

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

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

5.6.2 Environmental Impacts and Mitigation Measures

a. Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

LESS THAN SIGNIFICANT. In the Windsor area, two Alquist-Priolo Act Earthquake Fault Zones have been established: one for the Healdsburg-Rodgers Creek fault and one for the Maacama fault. However, the substation site and distribution line work areas are not located in either of these Earthquake Fault Zones, and there are no active surface-fault traces at the project sites. Therefore, the potential for surface-fault rupture is low, and the impact would be less than significant.

ii) Strong seismic ground shaking?

LESS THAN SIGNIFICANT. There are three major active fault zones that have the potential to generate strong ground shaking in the project area: the Healdsburg-Rodgers Creek, the San Andreas, and the Maacama. The San Andreas Fault Zone is located about 19 miles southwest of Windsor and is considered to be the most substantial seismic hazard in California. According to the Earthquake Hazard Map for Windsor, the shaking severity level is expected to be strong if a major earthquake occurs (ABAG 2010). Several other active faults have the potential to cause widespread damage to the project region and are listed in Table 5.6-2. Sonoma County has a 17.7 percent probability of experiencing ground shaking from at least one major earthquake (Moment Magnitude of 6.7 or greater) by 2031 (Working Group on California Earthquake Probability 2003).

The project area is relatively flat. The area is not prone to lateral spreading, landslides, liquefaction or other seismically induced ground failures. Project facilities would be engineered to withstand expected ground motions without substantial adverse impacts. However, if a significant seismic event occurs nearby, project facilities could be affected. Project design would be in accordance with the CPUC's General Order 95 and all other applicable state requirements, including the California Building Code. Conformance to design standards developed for the project site would minimize the effect of strong seismic shaking that could occur. Project construction would neither affect any existing geologic feature nor expose people to geologic hazards. Therefore, impacts due to strong ground shaking would be less than significant.

iii) Seismic-related ground failure, including liquefaction?

LESS THAN SIGNIFICANT. 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 relatively near the ground surface are most susceptible to liquefaction. The soils present in the project area have low susceptibility to liquefaction (ABAG 2001). In addition, facilities would be designed to reduce the minor threat of damage to a less than significant level.

iv) Landslides?

NO IMPACT. The proposed project is located on relatively level ground; therefore, the project site is not susceptible to landslides.

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

LESS THAN SIGNIFICANT. The dominant soils at the proposed substation site are from the Huichica and Haire Series. Huichica Series soils are moderately well-drained, runoff and permeability are moderately slow to very slow, erosion hazard is slight, and the expansion potential is low to medium. Haire Series soils are moderately well-drained, runoff is slow to rapid, and permeability is very slow.

Construction would occur in relatively flat terrain and would involve minimal grading. Erosion control best management practices (BMPs) would be used where excavation and grading occurs as would be required by the project NPDES permits and the SWPPP plan (**APM WQ-1, APM WQ-4**). Both temporary methods, such as laying down straw, and long-term methods such as laying down gravel within the substation yard would limit the potential for soil erosion. With proper construction practices, there should be no notable erosion or transport of sediment from the site. Engineering-level geotechnical studies would be completed to ensure that the project design adequately accounts for site-specific soil conditions.

Topsoil would be salvaged from areas where grading would otherwise result in loss of topsoil, and the salvaged soil would be used to reclaim areas of temporary construction disturbance. Once temporary surface disturbances are complete, areas that would not be subject to additional disturbance would be stabilized by landscaping or gravel. Excavated soil from pole replacement drilling activities would be placed in spoil piles adjacent to each hole and used for backfilling purposes and properly compacted. Excavated soil from trenching activities would be stockpiled and new thermal select or controlled backfill would be imported, installed and compacted. A road-based backfill or slurry concrete cap would be installed, and the road would be restored in compliance with the encroachment permit from the Town of Windsor. With the implementation of these BMPs and APMs, impacts due to erosion or loss of topsoil would be less than significant.

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

NO IMPACT. The proposed substation site is dominated by soils from the Huichica and Haire Series. Huichica Series soils are moderately well-drained, runoff and permeability are moderately slow to very slow, erosion hazard is slight, and the expansion potential is low to medium. Haire Series are moderately well-drained, runoff is slow to rapid, and permeability is very slow. There are no unstable geologic units in the proposed project area; therefore, no impact is expected.

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

LESS THAN SIGNIFICANT. The soils at the proposed substation site are loam and clay, which are listed as having a moderate expansion potential. Potential for expansive soil conditions would be accounted for in the design and construction practices of the project, thereby ensuring that impacts are less than significant.

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

LESS THAN SIGNIFICANT. Huichica and Haire Series soils dominate the substation site. Runoff from these soils is slow for Huichica and slow to rapid for Haire, and permeability is moderately slow to very slow (estimated at 60 minutes per inch). Therefore, the soil drainage characteristics would not be appropriate for onsite wastewater disposal systems. Since no on-site waste water disposal would be required, there would be no impact. See Section 5.9 for information regarding stormwater runoff from the project site.

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