

2.6 GEOLOGY SOILS, AND SEISMICITY

<i>Issues (and Supporting Information Sources):</i>	<i>Potentially Significant Impact</i>	<i>Less Than Significant with Mitigation Incorporation</i>	<i>Less Than Significant Impact</i>	<i>No Impact</i>
GEOLOGY, SOILS, AND SEISMICITY—				
Would the proposed project:				
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.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
ii) Strong seismic ground shaking?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iii) Seismic-related ground failure, including liquefaction?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
iv) Landslides?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b) Result in substantial soil erosion or the loss of topsoil?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
c) Be located on geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

SETTING

PROPOSED PROJECT

The surface geology along the project route has been mapped as primarily artificial fill, with some bedrock (serpentinite), and a small amount of alluvium. A major portion of the project is within the Islais Creek Basin. Prior to the late 1800s, the Islais Creek Basin consisted of a small bay and tidal marsh surrounded by hills. Since that time, the marshland and bay have been extensively filled. Significant portions were graded by excavating rock outcrops and soil overburden and using excavated material to fill low lying areas and the bay. The fill overlying bedrock is mostly excavated serpentinite of variable compactness with some areas of poorly to

moderately compacted sand and/or clay. The original shoreline along the south side of Islais Creek Basin extended approximately along Evans Avenue.

The project is located in an area of very high seismic risk. This results from its placement adjacent to a major tectonic plate interface between the North American and Pacific crustal plates. Relative movements of these plates along their interface at the San Andreas Fault occur not as a continuous drifting, but rather as a series of intermittent slips which are felt as earthquakes. In addition to the main trace of the San Andreas Fault, strain buildup resulting from movements along the plate interface is relieved by earthquakes occurring on many smaller faults throughout the Bay Area.

The proposed project is located within existing roadways, a paved parking lot, a vacant lot, and existing switch yards in the Potrero Hill/Hunters Point area of San Francisco.

ALTERNATIVE 1

The project setting for Alternative 1 is the same as under the proposed project.

ALTERNATIVE 2

The project setting for Alternative 2 is the same as under the proposed project.

ALTERNATIVE 3

The project setting for Alternative 3 is the same as under the proposed project.

NO PROJECT ALTERNATIVE

The setting for the No Project Alternative is the same as current conditions since construction of a 2.5 mile cable project would not occur.

REGULATORY CONTEXT

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zones Act), signed into law in December 1972, requires the delineation of zones along active faults in California. The purpose of the Alquist-Priolo Act is to regulate development on or near fault traces to reduce the hazard of fault rupture and to prohibit the location of most structures for human occupancy across these traces. Cities and counties must regulate certain development projects within the zones, which includes withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement (Hart, 1997). Surface fault rupture is not necessarily restricted to the area within a Fault Rupture Hazard Zone, as designated under the Alquist-Priolo Act. The project area is not located within such a zone.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure, and from other hazards caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit is granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. Geotechnical investigations conducted within Seismic Hazard Zones must incorporate standards specified by Council for Geoscience Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards (CGS, 1997). The CGS has completed seismic hazard mapping for portions of California most susceptible to liquefaction and earthquake-induced landsliding, including the City and County of San Francisco.

California Building Standards Code

The California Building Standards Code is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24. CCR Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in CCR Title 24 or they are not enforceable (Bolt, 1988).

Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The California Building Code incorporates by reference the UBC with necessary California amendments. About one-third of the text within the California Building Code is tailored for California earthquake conditions (ICBO, 1997). The project area is located within Zone 4, which, of the four seismic zones designated in the United States, is expected to experience the greatest effects from earthquake ground shaking and therefore has the most stringent requirements for seismic design. Notwithstanding, the national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies.

Community Safety Element

A revised version of the Community Safety Element of the San Francisco General Plan was adopted by the Planning Commission on April 27, 1997, and approved by the Board of Supervisors on August 11, 1997. The updated Element continues current policies that require new structures built in areas where site conditions could pose hazards, such as liquefaction or landslide, to be constructed in ways that reduce those hazards. Policy 2-3 is to “consider site soils conditions when reviewing projects in areas subject to liquefaction or slope instability.” Policy 2-9 is to “consider information about geologic hazards whenever City decisions that will influence land use, building density, building configuration or infrastructure are made.” (City and County of San Francisco, 1997)

To implement the life safety policies of the Community Safety Element, as well as the Seismic Hazard Mapping Act, engineers and inspectors at the Department of Building Inspection (DBI)

should work closely with a geotechnical team to ensure that all life safety issues are addressed by special site investigations and that appropriate recommendations are included in a geotechnical report, if needed. The recommendations are incorporated in the permit requirements for proposed construction. Each proposed construction site is evaluated individually, based on its actual surface and subsurface conditions.

IMPACTS DISCUSSION OF GEOLOGY, SOILS, AND SEISMICITY

METHODOLOGY AND SIGNIFICANCE CRITERIA

The analysis of the potential intensity of impacts to geology and soils were derived from the available soil maps, technical publications, test data, and other relevant publications characterizing the project area. This information was compared with the construction and design criteria of the proposed project and alternatives. To determine the level of significance of the impacts anticipated from the proposed project, the project's effects were evaluated as provided under the revised CEQA guidelines. These guidelines are summarized in the checklist provided at the beginning of this section.

PROPOSED PROJECT

The main potential project-related hazard to structures and people in the project area would be from seismic activity. The project site is located in the Coast Ranges Geomorphic Province, which is an area of relatively high seismic activity. Several major northwest-trending fault zones are anticipated to generate major earthquakes that could induce significant ground shaking at the site, including the San Andreas Fault Zone (the dominant fault zone in California), and a number of smaller fault zones are located within 40 miles of the project site. In addition to the San Andreas and Hayward faults, a major earthquake on any of the faults listed in **Table 2.6-1** could produce strong ground shaking at the site, affecting the proposed facilities. Shaking amplification is rated as “Extremely High” (8 on a scale of 1 to 8, with 8 rating the highest amplification) and the modified Mercalli intensity rating as high as IX-Violent (9 on a scale of 1 to 10, with 10 rating as very violent) for a major earthquake on the entire San Andreas Fault (ABAG, 2004). In an earthquake of that magnitude, damage to structures, roads, and infrastructure would be heavy throughout the project area. Geologic and seismic hazards that present the greatest potential impact to the project include strong ground shaking and seismically induced ground deformations due to liquefaction, lateral spreading, and differential settlement.

Expansive Soils

Expansive soils possess a “shrink-swell” behavior. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Structural damage may occur over a long period of time, usually the result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. The mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

**TABLE 2.6-1
FAULTS IN THE PROJECT VICINITY**

Fault	Activity^a	Distance (miles)	MCE^b
San Andreas	Holocene (Active)	7.5	8.3
Hayward	Holocene (Active)	11	7.0
Seal Cove – San Gregorio	Holocene (Active)	10.5	7.1
Calaveras	Holocene (Active)	21	7.0

^a Age is the period of recorded or most recent geologic evidence of earthquake displacement on a fault.

^b MCE is the Maximum Credible Earthquake, Richter magnitude, an estimate of the largest earthquake that is judged by geologic studies to be capable of occurring on a fault or segment of a fault.

SOURCE: USGS, 2004.

Mitigation Measure GEO-1: A site-specific, design level geotechnical investigation shall be performed to assess the extent and consequence of the expansive soils. The sub grade shall be prepared and foundations constructed as recommended in the investigation to limit the impact due to expansive soils to less than significant. Recommendations and conclusions determined by a registered geotechnical engineer or qualified civil engineer shall be incorporated in the final design as part of the project. The design measures selected to mitigate expansive soil hazards shall be submitted to and approved by PG&E and the CPUC.

Soil Erosion

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, and the action of waves, wind and underground water. Soils containing high amounts of fine sands or silt can be easily erodible, while clay soils are less susceptible. Excessive soil erosion can eventually lead to damage of building foundations and roadways. At the project site, areas that are susceptible to erosion are those that are underlain by Bay Mud and other fine grained material and also areas where the soil would be exposed during the construction phase. Typically, the soil erosion potential is reduced once the soil is graded and covered with concrete, structures or asphalt. The mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

Mitigation Measure GEO-2: During construction and grading, erosion and sediment control measures shall be conducted in accordance with best management practices for the reduction of pollutants in runoff (refer to Section 2.8, Hydrology and Water Resources). The components of the proposed program would be subject to NPDES requirements and would require the acquisition of a NPDES general construction permit. Erosion of soil materials to local water ways and its affects on water quality are further discussed in Section 2.8, Hydrology and Water Resources. Best

management practices for sediment and dust control shall be implemented to limit the impact due to erosion to less than significant. Best management erosion control measures shall also be implemented in unpaved areas, including the property between Cesar Chavez and Marin Street.

Differential Settlement

If not properly engineered, loose, soft, soils comprised of sand, silt, and clay have the potential to settle after a building or other load is placed on the surface. Differential settlement of the loose soils generally occurs slowly, but over time can amount can result in damage to structures. The weak and compressible nature of Bay Mud and artificial fills that have not been places using good engineering practices provide poor support for structure and infrastructure. Differential settlement can damage buildings and their foundations, roads and rail lines, and result in breakage of underground pipes.

Fault Rupture

Ground fault rupture is the direct manifestation of the movement that has occurred along a fault, projected to the ground surface. It consists of concentrated, permanent deformation of the ground surface, and in major earthquakes, can extend along the trace of the fault for many miles. This deformation can be in either a horizontal and/or vertical direction. Depending on the type of soils present at the site, the zone of ground deformation associated with fault rupture may be limited to a band a few inches wide, located directly over the fault, or it may be spread out over several hundred feet. A ground-surface rupture involving more than a few inches of movement within a concentrated area will cause major damage to the structures that cross it. Fault displacements associated with great earthquakes may be as large as 30 feet. In general, the precise location and total length of faults are not known because they are covered by alluvium. Fault displacements produce forces so great the best method of limiting damage to structures is to avoid building in areas close ground traces of faults.

Liquefaction and Seismic Related Ground Failure

Liquefaction is a phenomenon whereby unconsolidated and saturated soils lose cohesion and are converted to a fluid state as a result of severe vibratory motion. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluid-like behavior of the soil. Four kinds of ground failure commonly result from liquefaction: lateral spread, flow failure, ground oscillation, and loss of bearing strength. *Lateral spreading* is a horizontal displacement of surficial blocks of sediments resulting from liquefaction in a subsurface layer that occurs on slopes ranging between 0.3 and 3 percent and commonly displaces the surface up to tens of meters. *Flow failures* occur on slopes greater than 3 degrees and are primarily liquefied soil or blocks of intact material riding on a liquefied subsurface zone. *Ground oscillation* occurs on gentle slopes when liquefaction occurs at depth and no lateral displacement takes place. Soil units that are not liquefied may pull apart from each other and oscillate on the liquefied zone. The *loss of bearing strength* can occur beneath a structure when the underlying soil loses strength and liquefies. When this occurs, the structure can settle, tip, or even become buoyant and “float”

upwards. Liquefaction and associated failures could damage foundations, disrupt utility service, and cause damage to roadways.

Soil liquefaction causes ground failure that can damage roads, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at depths less than 40 feet (ABAG, 2003). In addition, liquefaction can occur in unconsolidated or artificial fill sediments located in the Project Area and other reclaimed areas along the margin of San Francisco Bay. The depth to groundwater influences the potential for liquefaction in this area, in that sediments need to be saturated to have a potential for liquefaction (Helley and LaJoie, 1979). Hazard maps produced by the Association of Bay Area Governments (ABAG) depict liquefaction and lateral spreading hazards for the entire Bay Area in the event of a significant seismic event (ABAG, 2003).¹ According to these maps, the project site is in an area expected to have a high potential to experience liquefaction. The CGS has designated the project and surrounding area as a Seismic Hazard Zone (CGS, 2001) for liquefaction potential; the mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

Mitigation Measure GEO-3: A site-specific, design level geotechnical investigation, shall be performed to assess the potential for liquefaction and seismic related ground failure in susceptible areas along the selected project route. The duct bank and vaults shall be designed to accommodate or mitigate the effects of ground settlement and loss of foundation bearing strength in the event of an earthquake. A geotechnical assessment of the rail crossings at Third and 23rd Streets (Proposed Route, Alternative 1, and Alternative 2), Third and Evans Avenue (If Proposed Route is selected), and Evans Avenue and Quint (If Proposed Route or Alternative Route 2 is selected), shall be performed to ensure that the boring alignment and bore casing design appropriately addresses and minimizes the impact of liquefaction. Recommendations and conclusions determined by a registered geotechnical engineer or qualified civil engineer shall be incorporated in the final design as part of the project. The design measures selected to mitigate liquefaction shall be submitted to and approved by PG&E and the CPUC.

Earthquake-Induced Settlement

Consolidation of loose soils and poorly consolidated alluvium can occur as a result of strong seismic shaking, causing uniform or differential settlement of building foundations. Structures supported on deep pile foundations are more resistant to such settlements. However, in the 1985 Mexico Earthquake, buildings supported on piles experienced substantial damage due to differential settlements between pile-supported buildings and non-supported slabs-on-grade.

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid consolidation and settling of subsurface materials (particularly loose, noncompacted, and variable sandy sediments) due to the rearrangement of soil particles during prolonged ground shaking. Settlement can occur both

¹ Lateral spreading is a ground failure associated with liquefaction and generally results from predominantly horizontal displacement of materials toward relatively unsupported free slope faces.

uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or Bay Mud. Areas underlain by artificial fill would be susceptible to this type of settlement. Given the geologic setting of the Proposed Project, this area could be subjected to earthquake-induced settlement. Accordingly, this issue is discussed in further detail in the Checklist Impact Conclusion section of this chapter. The mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

Mitigation Measure GEO-4: A site-specific, design level geotechnical investigation shall be performed to assess the extent and consequence of ground instability. The duct bank, vaults, and substation structures shall be designed to accommodate or mitigate the effects of ground settlement and loss of foundation bearing strength in the event of an earthquake. Recommendations and conclusions determined by a registered geotechnical engineer or qualified civil engineer shall be incorporated in the final design as part of the project. The design measures selected to mitigate ground instability hazards shall be submitted to and approved by PG&E and the CPUC.

Landslides

A landslide is the downhill movement of masses of earth under the force of gravity. Earthquakes can trigger landslides in areas that are already landslide prone. Slope gradient is often a clue to stability. Landslides are most common on slopes of more than 15 degrees, and can generally be anticipated along the edges of mesas and on slopes adjacent to drainage courses. The mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

Mitigation Measure GEO-5: A site-specific, design level geotechnical investigation shall be performed to define the extent of the landslide risk in susceptible areas along the selected project route. The duct bank and vaults shall be designed to avoid an area prone to landsliding. Recommendations and conclusions determined by a registered geotechnical engineer or qualified civil engineer shall be incorporated in the final design as part of the project. The final design measures selected to mitigate landslide hazards shall be submitted to and approved by PG&E and the CPUC.

Ground Shaking

Ground shaking includes both horizontal and vertical motions that can last up to several minutes during major earthquakes. Generally, the intensity of ground motion decreases with distance from the zone of fault rupture. However, local soil conditions can amplify and modify the character of ground motion to produce more intense effects at individual sites. Strong ground shaking from a major earthquake could affect San Francisco within the next 30 years.

Earthquakes on the active faults in the area, including the San Andreas and Hayward faults are expected to produce significant ground shaking at the project site. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter. Historic earthquakes have caused strong ground shaking and damage in the San Francisco Bay Area, the most recent being

the Magnitude² 6.9 Loma Prieta earthquake in October 1989. The epicenter was approximately 40 miles southeast of the project site, but this earthquake nevertheless caused strong ground shaking for about 20 seconds and resulted in varying degrees of structural damage throughout the Bay Area.

The 1906 San Francisco earthquake, with an estimated moment magnitude (Mw)³ of 7.9, produced strong (VIII) to violent (IX) shaking intensities (ABAG, 20034). The 1989 Loma Prieta earthquake, with an Mw of 6.9, produced very strong (VIII) shaking intensities in the project area. (ABAG, 2004).

It is estimated that ground shaking causes over 90 percent of all earthquake-related damage to structures. The common way to describe ground motion during an earthquake is with the motion parameters of acceleration and velocity in addition to the duration of the shaking. A common measure of ground motion is the Peak Ground Acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 32.2 feet per second squared. In terms of automobile accelerations, one “g” of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

The lowest values recorded were 0.06 g in the bedrock on Yerba Buena Island from the Loma Prieta earthquake (CGS, 1990). The presence of non-engineered artificial fill and Bay Mud in the project area could intensify ground shaking effects in the event of an earthquake on one of the aforementioned faults in the vicinity of the project area. The PGA for this project has been previously estimated at 0.61 g with a 10 percent probability of exceeding the estimated 0.61 g in 50 years. This probability exceedance equates to an event with a recurrence interval of 475-years, and is consistent with the Design Basis Earthquake inherent in modern building codes. The presence of non-engineered artificial fill and Bay Mud in the project area could intensify ground shaking effects in the event of an earthquake on one of the aforementioned faults in the vicinity of the project area. The mitigation measure listed below would reduce potentially significant impacts to a less than significant level.

Mitigation Measure GEO-6: Switchyard improvements, new substation equipment, structures and foundations shall be procured and designed in accordance with PG&E’s engineering practices, which include the application of seismic design provisions (e.g., the Institute of Electrical and Electronic Engineers (IEEE) 693 for selected critical equipment, the current edition of the California Building Code (CBC), and various industry standards) intended to mitigate earthquake damage to substation equipment and structures. The design criteria selected to mitigate ground shaking hazards shall be submitted to and approved by PG&E and the CPUC.

² The Richter magnitude (M) scale reflects the maximum amplitude of a particular type of seismic wave.

³ Moment magnitude is related to the physical size of a fault rupture and movement across a fault. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CDMG, 1997b). The concept of “characteristic” earthquake means that we can anticipate, with reasonable certainty, the actual earthquake that can occur on a fault.

ALTERNATIVE 1

The setting of Alternative 1 is located within existing roadways, the existing HDD bore crossing at Islais Creek, and existing switchyards in the Potrero Hill/Hunters Point area of San Francisco. In general, the geologic, soils, and seismic setting would be similar to the Proposed Project Setting, described above. Differences in the setting as a result of utilizing the HDD bore crossing at Islais Creek are further discussed below:

Liquefaction and Seismic-Related Ground Failure

The bore casing beneath Islais Creek exists in soil that is susceptible to landsliding, lateral spreading, subsidence, and liquefaction. To address this issue, further geotechnical investigations to assess the extent and consequence of ground instability are required. Implementation of **Mitigation Measure GEO-3** could reduce potentially significant impacts to a less than significant level. In the event that soil instability is deemed to be a risk to the bore crossing, remediation or replacement may be necessary. Through proper engineering, the potential impacts would be less than significant with mitigation incorporated as required.

ALTERNATIVE 2

Alternative 2 is located within existing roadways, a paved parking lot, and existing switch yards in the Potrero Hill/Hunters Point area of San Francisco. Accordingly, the entire geologic and seismic impacts are the same under the Proposed Project Setting.

ALTERNATIVE 3

The project impacts for Alternative 3 are the same as under Alternative 1.

NO PROJECT ALTERNATIVE

The No Project Alternative would avoid all impacts to geology, soils and seismicity associated with the proposed project.

CHECKLIST IMPACT CONCLUSIONS

- a.i) The project site is not located in an Alquist-Priolo Earthquake Fault Zone, as defined by the California Geological Survey. According to the PEA, a short pre-Quaternary fault and shear zone was mapped by Schlocker (1974) extending west-northwestward from about 22nd Street and Illinois Street to 20th Street and Missouri Street. However, this fault is not considered active or potentially active. The nearest active faults are the San Andreas fault, located 7.5 miles west of the site; the Seal Cove-San Gregorio fault, located 10.5 miles west of the site; the Calaveras fault, located 21 miles east of the site; and the Hayward fault, located 11 miles east of the site. Since the site is not located on an active or potentially active fault, the potential for surface fault rupture is low and the impact is considered less than significant.

- a.ii) The PEA identifies 0.61g as the estimated Peak Ground Acceleration with a 10% probability of exceedance in 50 years. Peak spectral accelerations may be on the order of 1.0 g. These are substantial accelerations which must be considered in the design process for all components of the project. Through proper engineering design and implementation of **Mitigation Measure GEO-1**, the potential impacts on the project due to ground shaking would be less than significant. Additionally, the project itself would not affect the ground shaking hazard for other structures in the area.
- a.iii) The CGS has included the non-bedrock areas along the project route in the Liquefaction Hazard zone for the City and County of San Francisco (CGS, 2001). Because of the variable or heterogeneous nature of the artificial fills, generalized liquefaction is estimated to be unlikely; however, localized area of liquefaction may occur in fill across the area. Through proper reinforcement, engineering design and implementation of **Mitigation Measure GEO-3**, the potential impacts on the project due to liquefaction would be less than significant. Additionally, the project itself would not affect the liquefaction potential for other structures in the area.
- a.iv) Localized slope failures could occur during a severe earthquake along the Islais Creek channel. Through proper reinforcement, engineering design and implementation of **Mitigation Measure GEO-3**, the potential impacts due to landsliding on the project would be less than significant. Additionally, the project itself would not affect the landslide potential in area.
- b) During construction, excavations for the duct bank, vaults, bore pits, and switchyard foundations have the potential to generate water-carried sediment and wind-blown dust. Construction activities involving soil disturbance, excavation, and grading activities could result in increased erosion and sedimentation to surface waters. Through best management practices and implementation of **Mitigation Measure GEO-2**, the impact that the project would have on soil erosion would be less than significant.
- c) Portions of the project areas are susceptible to landsliding, lateral spreading, subsidence, and liquefaction. Through proper reinforcement, engineering design and implementation of **Mitigation Measure GEO-4**, the potential impacts on the project due to ground instability would be less than significant. Additionally, the project itself would not affect the ground stability for other structures in the area.
- d) According to the PEA, portions of the natural soils and variable fills may have expansive soils. Through proper reinforcement, engineering design and implementation of **Mitigation Measure GEO-1**, the potential impacts on the project due to expansive soils would be less than significant. Additionally, the project itself would not affect the ground stability for other structures in the area.
- e) The project does not include the installation of a septic tank or use of alternative wastewater disposal systems; therefore, there would be no impacts.

REFERENCES – Geology, Soils, and Seismicity

- Association of Bay Area Governments (ABAG), Earthquake Hazards Map for San Francisco, Accessed online <http://www.abag.ca.gov/cgi-bin/pickmapx.pl>, June 2004a.
- Association of Bay Area Governments (ABAG), Modeled Shaking Intensity Map for San Francisco, 1989 Loma Prieta and 1906 San Andreas Earthquake, Accessed online <http://www.abag.ca.gov/cgi-bin/pickmapx.pl>, June 2004b.
- ATI, Draft Geology and Seismicity Technical Memorandum, PG&E Potrero to Hunters Point 115 kV Cable Project, Document Number E2105-MEM-001-RV1, June 23, 2004.
- Black & Veatch, *Potrero – Hunters Point 115kV Underground Cable Project, Alternative Routes Feasibility Study, Rev. 0: Preliminary Report for Client Review*, October 3, 2003.
- Bolt, Bruce, A. *Earthquakes*, W.H. Freeman and Company, New York, NY, 1988.
- California Geological Survey, Special Publication 104, *The Loma Prieta Santa Cruz Mountains California Earthquake of 17 October 1989*, 1990.
- California Geologic Survey, *State of California Seismic Hazard Zones, City and County of San Francisco Official Map*, November 17, 2001.
- California Geological Survey (CGS), *Guidelines for Evaluating and Mitigating Seismic Hazards*, CDMG Special Publication 117, 1997.
- City and County of San Francisco, *Protest of the City and County of San Francisco to the Application of Pacific Gas & Electric Company for a Permit to Construct the Potrero to Hunters Point 115kV Cable Project*, May 3, 2004.
- City and County of San Francisco, *San Francisco General Plan, Community Safety Element*, adopted April 27, 1997 by the San Francisco Planning Commission, approved August 11, 1997 by the Board of Supervisors.
- City and County of San Francisco, *Community Safety - An Element of the Master Plan of the City and County of San Francisco*, March 1996.
- Dames & Moore, *Preliminary Geotechnical Evaluation, Site Development at Proposed Cargo Way Site, Metro East Maintenance Facility, Muni Third Street Light Rail Project*, March 4, 1997.
- Essex Environmental, *PG&E Potrero to Hunters Point 115kV Cable Project, Proponent's Environmental Assessment*, December 2003.
- International Conference of building Officials (ICBO), *Uniform Building Code*, Whittier, CA, 1997.
- Pacific Gas & Electric Company, *Reply to Protest of the City and County of San Francisco to the Application of Pacific Gas & Electric Company for a Permit to Construct the Potrero to Hunters Point 115kV Cable Project*, May 24, 2004.
- United States Geological Survey (USGS), *Earthquake Hazards Program – Northern California*. Online <http://www.quake.wr.usgs.gov/research/seismology/wq/02>.