3.6 GEOLOGY AND SOILS

GEOLOGY AND SOILS – Would the Project:	**Potentially Significant Impact**	**Less Than Significant with Mitigation**	**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 ground shaking?	☐	☐	☒	☐
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	☐	☐	☐	☒
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 waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒

3.6.1 Environmental Setting

3.6.1.1 Regional Setting

The Project site lies within the Coast Ranges geomorphic region. The Coast Ranges region lies between the Pacific Ocean and the Great Valley (Sacramento and San Joaquin Valleys) geomorphic region and stretches from the Oregon border to the Santa Ynez Mountains near Santa Barbara (ESA 2009). Much of the Coast Ranges are composed of marine sedimentary deposits and volcanic rocks that form northwest trending mountain ridges and valleys, running subparallel to the San Andreas Fault Zone (Figure 3.6-1). In the San Francisco Bay Area, movement along this plate boundary is distributed across a complex system of strike-slip, right-lateral, parallel and sub-parallel faults. These faults include the San Andreas, Hayward, Rodgers Creek-Healdsburg, Concord-Green Valley, Greenville-Marsh Creek, Calaveras, and West Napa Faults (ESA 2009) (Figure 3.6-1).

The Coast Ranges can be further divided into the northern and southern ranges, which are separated by the San Francisco Bay. The San Francisco Bay lies within a broad depression created from an east-west expansion between the San Andreas and the Hayward Fault systems (ESA 2009) (Figure 3.6-1). The San Francisco and San Pablo Bays including shoreline areas are generally comprised of soft compressible sediments known as Bay Mud, which can be very thick in areas (ESA 2009) (see Figure 1-1).

3.6.1.2 Project Setting

Geology

The Project site is located in northern Contra Costa County along and within San Pablo Bay. Geologically, this region is characterized by a series of northwest trending mountains and valleys. The region has undergone a complex geologic history of folding, faulting, uplift, sedimentation, volcanism, and erosion (ESA 2009).

The region is characterized primarily by sedimentary rocks, occasional volcanic rocks, and alluvial deposits. Regional basement rocks consist of the highly deformed Great Valley Sequence, which include massive beds of marine sandstone intermixed with siltstone and shale, and marine sandstone and shale overlain by soft non-marine units. Unconsolidated alluvial deposits, artificial fill, and estuarine deposits underlie the marginal areas along San Pablo Bay and Carquinez Strait (ESA 2009) (see Figure 1-1).

Faults and Seismicity

The Project is located in the seismically active San Francisco Bay region. The San Francisco Bay region is situated on a plate boundary marked by the San Andreas Fault System, which consists of several northwest trending active and potentially active faults, as shown on Figure 3.6-1. The 2007 Working Group on California Earthquake Probabilities evaluated the probability of one or more earthquakes of magnitude 6.7 or higher occurring in the State of California over the next 30 years. The result of the evaluation indicated a 63 percent likelihood that such an earthquake event would occur in the Bay Area (ESA 2009). The site could be subjected to damage from movement on any one of the active San Francisco Bay Area earthquake faults. The Project area is located approximately mid-way between the active Hayward and Concord-Green Valley faults, as shown on Figure 3.6-1.

Figure 3.6-1. Regional Fault Map

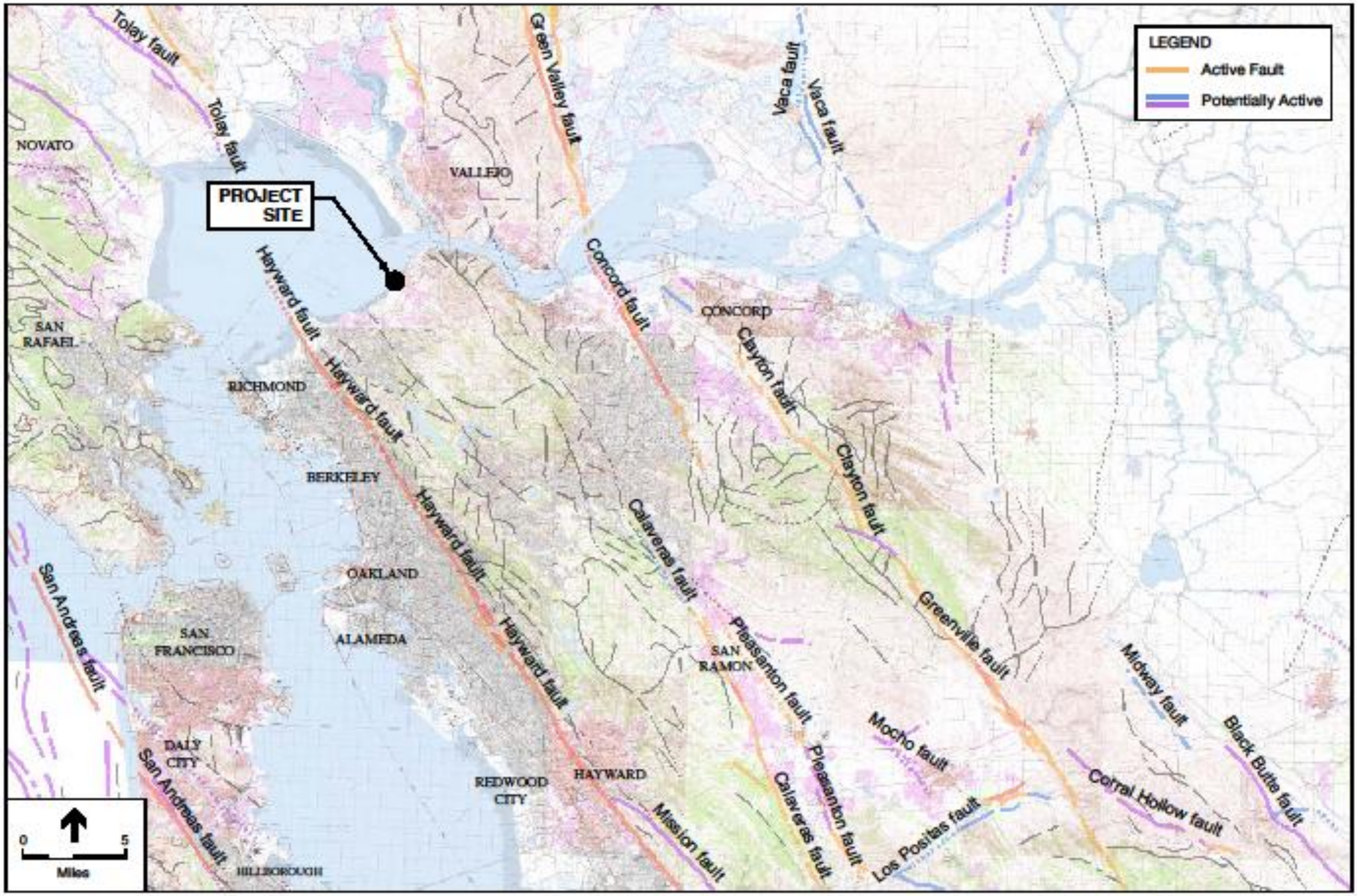

Table 3.6-1 lists the nearest active and potentially active faults, Maximum Credible Earthquake (MCE), and the probability of occurrence. The closest active fault to the Project area is the Hayward fault, located approximately 7 miles to the southwest (ESA 2009).

Table 3.6-1. Active Faults in the Project Site Vicinity

Fault	Location and Direction from Project Area	Recency of Movement	Fault Classification[a]	Historical Seismicity[b]	Maximum Moment Magnitude Earthquake (Mw)[c]
Hayward	7 miles southwest	Pre-Historic (possible 1836; 1868 ruptures) Holocene	Active	M6.8, 1868 Many <M4.5	7.1
West Napa	8 miles north	Holocene	Active	Not Applicable	6.5
Concord-Green Valley	9 miles east	Historic (1955) Holocene	Active	Historic active creep	6.9
Rodgers Creek	12 miles northwest	Historic Holocene	Active	M6.7, 1898 M5.6, 5.7, 1969	7.0
Pleasanton	22 miles southeast	Holocene	Active	Not Applicable	5.5
San Andreas	25 miles west	Historic (1906; 1989 ruptures)	Active	M7.1, 1989 M8.25, 1906 M7.0, 1838 Many <M6	7.9
Calaveras (northern)	25 miles southeast	Historic (1861 rupture) Holocene	Active	M5.6-M6.4, 1861 M4 to M4.5 swarms 1970, 1990	6.8
Marsh Creek-Greenville	28 miles southeast	Historic (1980 rupture) Holocene	Active	M5.6 1980	6.9

[a] An “active” fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 11,000 years). A “potentially active” fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not, of course, mean that faults lacking evidence of surface displacement are necessarily inactive. “Sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (Hart, 1997).

[b] Richter magnitude (M) and year for recent and/or large events. The Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave.

[c] Moment magnitude is related to the physical size of a fault rupture and movement across a fault. Moment magnitude provides a physically meaningful measure of the size of a faulting event (CGS 2002). The Maximum Moment Magnitude Earthquake (Mw), derived from the joint CGS/USGS Probabilistic Seismic Hazard Assessment for the State of California, 1996 (Peterson 1996).

Source: ESA 2009

3.6.1.3 Seismic Hazards

Seismic hazards as explained below include groundshaking, liquefaction, and other geological hazards such as lateral spreading, differential settlement, soil erosion, landslides, and inundation by encroaching waves (tsunami and seiches).

Groundshaking

Ground movement intensity during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill. Earthquake groundshaking may have secondary effects on certain foundation materials, including liquefaction and seismically induced settlement (ESA 2009).

Liquefaction

Liquefaction is the sudden temporary loss of shear strength in saturated, loose to medium-density granular sediments subjected to ground shaking. When this occurs, it can cause foundation failure of buildings and other facilities. The potential for liquefaction depends on a number of factors including the duration and intensity of earthquake shaking, particle size distribution of the soil, density of the soil, and elevation of the groundwater. According to the Association of Bay Area Governments (ABAG) Liquefaction Susceptibility Map, the land-based portions of the Project have a very low risk of liquefaction (ESA 2009). The mapping does not include submerged areas of the bay.

Other Geologic Hazards

- Differential Settlement. Soil that settles unevenly particularly after liquefaction has occurred because the soil layers that liquefy are not of a uniform thickness. Differential settlement can damage structures, including buildings and utilities.
- Landslides. Landslides consist of the movement of rock and soil down steep slopes. The potential risk of landslides is dependent on the slope and geology of an area as well as the amount of rainfall, excavation, and seismic activity. Landslides can cause severe damage to structures.
- Lateral Spreading. Refers to landslides that typically occur on gentle slopes and have rapid fluid-like flow movement.
- Soil Erosion. Loss of soil due to running water or wind. Most typically of concern in areas with steep slopes and exposed soils. Rates of erosion can vary depending on the soil material and structure, placement and human activity.

- <u>Tsunamis and seiches</u>. A tsunami is a long high sea wave caused by an earthquake, submarine landslide, or other disturbance. Due to the narrowness of the Golden Gate, tsunamis pose relatively little risk inside the Bay. A seiche is a standing wave oscillation in an enclosed waterbody that continues after the cessation of the originating force. Seiches may be triggered by atmospheric conditions or seismic events. Seiches and tsunamis can inundate nearshore areas.

3.6.2 Regulatory Setting

Federal and State laws and regulations pertaining to this issue area and relevant to the Project are identified in Table 3-1. Local goals, policies, and/or regulations applicable to this issue area are summarized below.

The County has policies in its General Plan to protect the long-term productivity and economic value of its soil resources. Consistent with the California Building code, the County also has restriction for building on certain soils and geological areas due to the geologic and erosions hazard.

3.6.3 Impact Analysis

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.

No Impact. There are no known active faults traversing the Project site and therefore, rupture of a known fault is not considered a potential geologic hazard that could affect the Project (see Figure 3.6-1). The Project would not construct any structures. The Project does not lie within or near an Alquist-Priolo Earthquake zone and would have a very low potential for fault rupture to occur near any of the Project elements. Therefore, there would be no impact from fault rupture.

ii) Strong seismic ground shaking?

Less than Significant Impact. The San Francisco Bay Area is considered to be seismically-active region. The Project site is located in an area that has the potential to be subject to significant groundshaking from an earthquake along any of the active faults located in the region including the Hayward Fault, the closest fault to the Project site (see Figure 3.6-1). However, the Project does not include construction of any habitable structures that could potentially be damaged or cause injury or death. Workers may be subject to groundshaking in the event that a significant earthquake occurred during the Project, but the likelihood of this occurring during the relatively short (less than 1 month) work period is relatively remote. Therefore, the potential impact from groundshaking is less than significant.

iii) Seismic-related ground failure, including liquefaction?

No Impact. Mapping compiled by ABAG shows that the land-based work sites of the Project are located in an area mapped as having a very low potential for liquefaction. The Project does not include the construction of any structures that could potentially be damaged or cause injury or death because of liquefaction. Therefore, there is no potential impact from liquefaction.

iv) Landslides?

No Impact. The land-based portions of the Project site are relatively level and would not be subject to any landslides. No impact would be expected.

b) Result in substantial soil erosion or the loss of topsoil?

Less than Significant Impact. Project activities would consist primarily of offshore work associated with the pipeline removal, which would not disturb surface soils. The land-based portions of the Project include the cutting and removing of about a 20-foot section of the pipeline and abandoning in place of the remaining 140 feet of subsurface wastewater pipeline. There is little potential for erosion throughout the small Project area due to the minimal soil exposure during the riprap removal and grouting process. All work would be conducted using Best Management Practices (BMPs) to avoid potential erosion, such as Project scheduling that avoids storm events, protection of any stockpiled material, and limiting the exposed soil in the area. The Project would not cause erosion and the impact would be less than significant.

c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

No Impact. The Project does not include the construction of any structures. There would be no impact from the pipeline removal and abandonment to the Project area from unstable soils including landslides, lateral spreading, subsidence, liquefaction, and collapse as discussed earlier in this same section.

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?

No Impact. The Project does not include any aboveground improvements that would be susceptible to the effects of expansive soils; therefore, there would be no impact from the Project.

e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?

No Impact. No septic tanks or alternative wastewater systems are proposed for the Project; therefore, there would be no impact from the Project.

3.6.4 Mitigation Summary

The Project would not result in significant impacts; therefore, no mitigation is required.