Issues (and Supporting Information Sources):	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
VI. GEOLOGY AND SOILS – Would the 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.	☐	☒	☐	☐
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 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 wastewater disposal systems where sewers are not available for the disposal of wastewater?	☐	☐	☐	☒

SETTING

In general, geologic materials consisting of inter-tidal marshland deposits, recent, unconsolidated alluvium and older, more consolidated bedrock underlie the existing pipeline corridor. The estuarine sediments found along the shorelines of Contra Costa County are soft, water-saturated mud, peat, and loose sands. The organic, soft, clay-rich sediments along the San Francisco and San Pablo Bays are referred to locally as Bay mud and can present a variety of engineering challenges due to its inherent low strength, compressibility, and saturated conditions. Bay mud and peat are subject to differential settlement under load and can cause slumping and landslides in sloped areas. Under seismically induced stress, Bay mud can fail causing lateral displacement. In some cases, especially in areas underlain by saturated sand deposits or artificial fill, intertidal areas underlain by Bay mud are susceptible to ground failure associated with liquefaction. Alluvium, eroded from the upland areas adjacent to the bay margin, is generally interfingered with or adjacent to the intertidal marshland deposits and consists of consolidated and unconsolidated coarse-grained sediments and finer-grained silts and clays. The areas of the pipeline that are located on intertidal deposits extend from Richmond to Hercules and from southern Port Costa to the Pittsburg Power Plant.

The portions of the pipeline between Hercules and Crockett are located on bedrock formations consisting of sandstone, conglomerate, and claystone. The Hercules Pump Station is supported on engineered artificial fill and bedrock formations consisting of sandstone, conglomerate, and claystone.

The pipeline segment from Crockett to Port Costa (unincorporated areas) is underlain by marine mudstone, sandstone, and conglomerate that is part of the Great Valley Sequence. The inherent strength and stability of the Great Valley Sequence bedrock units provides suitable foundation material with stable slopes, however, this bedrock is susceptible to landsliding in certain areas where the bedrock is excessively weathered, sheared, fractured, or contorted.

The 4,000-foot replacement section in Hercules is located on alluvial deposits. In Pittsburg, the pipeline generally runs along the border between the intertidal marshland and alluvial materials.

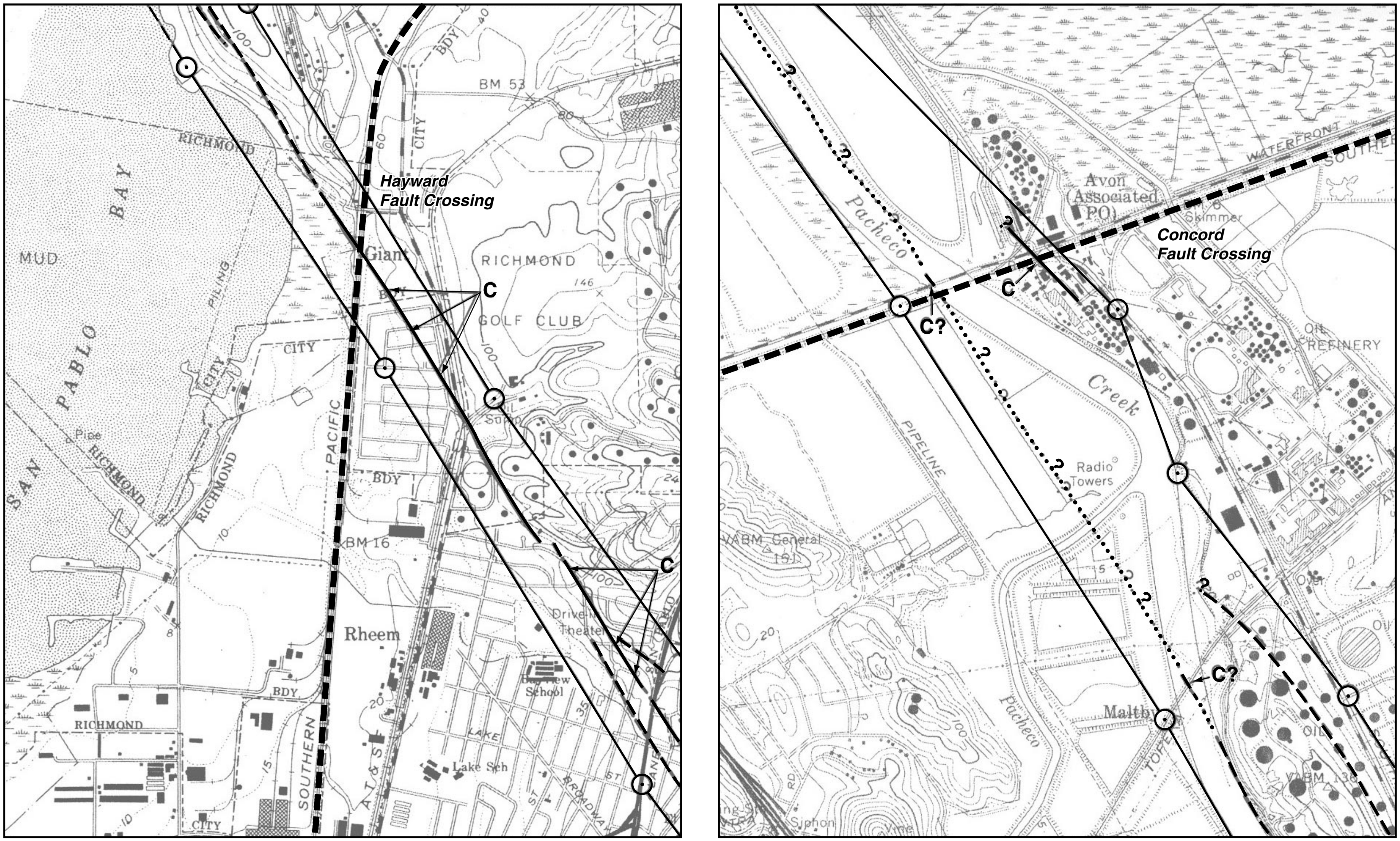
SEISMICITY

The fuel oil pipeline is located in the San Francisco Bay Area, a region containing both active and potentially active faults and intense seismic activity. The 1997 Uniform Building Code (UBC) locates the entire Bay Area within Seismic Risk Zone 4. Areas within Zone 4 are expected to experience maximum magnitudes and damage in the event of an earthquake (Lindenburg, 1998). The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 70 percent likelihood that such an earthquake event will occur in the Bay Area between 2000 and 2030 (USGS, 1999).

REGIONAL FAULTS

The pipeline crosses the active Hayward and Concord faults northwest of the City of San Pablo and east of the City of Martinez, respectively (**Figure 3**). The combined southern and northern segments of the Hayward fault, as well as the San Andreas fault and Calaveras fault, are considered by the USGS to pose the greatest threat of generating at least one earthquake with a magnitude 6.7 or greater earthquake over the 30 years (USGS, 1999).

The pipeline is also located near other active faults, such as the Clayton segment of the Marsh Creek-Greenville fault located 5 miles south, the Napa fault located 7 miles north, and the San Andreas fault located 20 miles west. The Hercules Pump Station is located approximately 2 miles from the Hayward fault. In addition, the existing pipeline, the proposed 4,000-foot replacement section, and the Hercules Pump Station cross or are located immediately adjacent to numerous potentially active faults such as the Franklin, Pinole, and Southampton faults.



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PG&E Richmond to Pittsburg Pipeline

Alquist-Priolo Fault Rupture Zones

These are delineated as straight line segments that connect encircled turning points so as to define earthquake fault zone segments. Fault traces are delineated by a solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed; query (?) indicates additional uncertainty. Evidence of historical offset indicated by C for displacement by creep or possible creep.

SOURCE: Environmental Science Associates

Figure VI-1
Alquist-Priolo Fault Rupture Zones

GEOLOGIC HAZARDS

LANDSLIDES

A landslide is a mass of rock, soil, and debris displaced down-slope by sliding, flowing, or falling. The susceptibility of land to slope failure is dependent on the slope and geology as well as the amount of rainfall, excavation or seismic activities. Steep slopes and down-slope creep of surface materials characterize areas most susceptible to landsliding. Landslides are least likely in topographically low alluvial fans and at the margin of the San Francisco Bay.

SOIL EROSION

Soil erosion is the process whereby soil materials are worn away and transported to another area either by wind or water. Rates of erosion can vary depending on the soil material and structure, placement and human activity. The erosion potential for soils is variable throughout the project area. Soil containing high amounts of silt can be easily erodible while sandy soils are less susceptible. Excessive soil erosion can eventually lead to damage of building foundations, roadways and dam embankments. Erosion is most likely on sloped areas with exposed soil; especially where unnatural slopes are created by cut and fill activities. Soil erosion rates can therefore be higher during the construction phase.

EXPANSIVE SOILS

Expansive soils possess a “shrink-swell” characteristic. 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.

SEISMIC HAZARDS

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake’s seismic waves. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Future faulting is generally expected along different strands of the same fault (CDMG, 1997). Ground rupture is considered more likely along active faults, which are referenced above.

Ground Shaking

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. The composition of underlying soils in areas located relatively distant from faults can intensify ground shaking. As the majority of the pipeline is located in unconsolidated estuarine and alluvial sediments, ground-shaking effects would be amplified during an earthquake.

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or near 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. 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, 1996). In addition, liquefaction can occur in unconsolidated or artificial fill sediments such as those located in reclaimed areas along the margin of San Francisco Bay. The depth of groundwater influences the potential for liquefaction in this area: the shallower the groundwater, the higher potential for liquefaction. Liquefaction potential is highest in areas underlain by Bay fills, Bay mud, and unconsolidated alluvium.

Seismically-Induced Landslides

As with landslides that occur due to static forces (described above) earthquakes can generate slope failures due to seismic ground motion dislodging slope material. The susceptibility of land (slope) failure during an earthquake is dependent on the level of ground shaking, underlying geology, thickness of alluvial material, degree of saturation.

REGULATORY BACKGROUND

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

The Alquist-Priolo Earthquake Fault Zoning Act (formerly the Alquist-Priolo Special Studies Zone Act), signed into law 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 an Alquist-Priolo 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. The California Division of Mines and Geology has not yet completed a preliminary Seismic Hazards Map for the areas encompassed by the project.

CALIFORNIA BUILDING CODE

The California Building Code is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code (CBSC, 1995). 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 Title 24 or they are not enforceable (Bolt, 1988).

Published by the International Conference of Building Officials, the Uniform Building Code is a widely adopted model building code in the United States. The California Building Code incorporates by reference the Uniform Building Code (UBC) with necessary California amendments. About one-third of the text within the California Building Code has been tailored for California earthquake conditions (ICBO, 1997).

GEOLOGY AND SOILS IMPACTS DISCUSSION

a-i) Portions of the pipeline corridor are located within an Alquist-Priolo Earthquake Fault Zone , as defined by the California State Department of Conservation, Division of Mines and Geology (CDMG) (Figure 3). The pipeline crosses the active Hayward and Concord faults northwest of the City of San Pablo and east of the City of Martinez, respectively. The potentially active Franklin, Pinole, and Southampton faults are not zoned as Earthquake Fault Zones under the Alquist-Priolo Act. Although these faults are susceptible to fault rupture, especially as secondary movement triggered by a nearby active fault, they are considered less of a seismic hazard than other active Bay Area faults because of their lower probability of activity and low potential to generate surface fault rupture.

In the event of an earthquake on the Hayward fault, sudden offset is expected to be approximately 5 feet of overall horizontal displacement (lateral offset of 3 feet and compression of 4 feet) as estimated by Harding-Lawson Associates (HLA) in 1974. HLA determined that lateral fault offset during an event on the Concord fault would be approximately 2 feet with negligible vertical component of movement. Where the pipeline crosses the Hayward and Concord faults, it is contained within an over-sized, reinforced concrete conduit to provide unrestrained movement for the pipe, thereby reducing overstress caused by sudden offset. Sufficient clearance for the pipe is provided so the pipe can move without being constrained by the walls of the conduit. With this design, the pipeline is subjected to horizontal and vertical displacements of the conduit but is not directly subjected to ground deformation (Bechtel, 1974).

The pipeline crosses the Hayward and Concord faults at angles less than 90 degrees. Because these faults exhibit relative lateral movement, axial elongation or compression can occur as the pipeline is stretched or compressed by surface displacements during an earthquake. The pipeline is designed to compensate for axial elongation or compression through flexibility provided by a U-shaped pipe configuration. Appropriate stress and strain evaluations were also incorporated into the design of the pipeline and conduit to ensure that the pipe would withstand dynamic loads from lateral offset of the faults.

Lateral movement of a fault trace not associated with an earthquake, known as tectonic creep, can also result in measurable displacement across a fault and eventual damage to structural features placed across the fault. The maximum estimated tectonic creep, or slip rate across the northern Hayward fault is 9 (+ 1) millimeters (0.354 inches) per year (USGS/CDMG, 1996). Tectonic creep on the Hayward fault was estimated by HLA (in 1974) at approximately 3 inches in 10 years of both lateral offset and compression. Tectonic creep on the Concord fault was estimated to result in 4 inches in 10 years of lateral offset, and 1 inch in 10 years of elongation. Bechtel incorporated design features for the pipeline that would compensate for the potential tectonic creep, which included placing the pipes in concrete conduits that would compensate for the movement. HLA recommended that tectonic creep rate and deformation at the Hayward and Concord fault crossings be monitored regularly as creep rates could increase or decrease significantly in the future. P.G.&E. found no documents that record monitoring of tectonic creep. Although U-bends compensate for displacement, axial elongation, or compression caused by fault movement, and thus far, PG&E reports no problems attributable to creep, the pipeline's present ability to withstand future offset generated by tectonic movement or sudden earthquake displacement cannot be fully determined, because the amount of pipeline distortion from historical creep is unknown. For example, if tectonic creep on the Hayward fault was to occur at the estimated 9 millimeters per year, it is conceivable that since the pipeline construction in 1974, this fault segment could have undergone up to 9 inches of displacement. As of 1974, street curbs built across the Concord fault in the City of Concord were observed to have moved 15 centimeters (6 inches) since 1949 (SFBCDC, 1974).

Impact VI.1: Although PG&E reports no problems attributable to tectonic creep, the pipeline's present ability to withstand future offset generated by tectonic movement or sudden earthquake displacement cannot be fully determined, because the amount of pipeline distortion from historical creep is unknown. Therefore, an assessment of historical and cumulative tectonic creep and an inspection of creep compensating design features is required at the pipeline-fault crossings to determine the current ability of the pipeline to accommodate future distortion from lateral or vertical offset, elongation, or compression in the event of continued tectonic creep or displacement during a characteristic earthquake on the Hayward and Concord

faults. The following mitigation measure would ensure that the existing flexibility of the pipeline is sufficient to withstand a substantial seismic event on the aforementioned faults.

Mitigation Measure VI.1: Prior to operation of the pipeline, the new owner (SPBPC) shall perform an evaluation of the effect of tectonic creep on the pipeline at the Hayward and Concord fault crossings. A civil or geotechnical engineer licensed by the State of California, with expertise in seismic design and structural seismic response shall conduct this evaluation. The evaluation shall include a review of available geotechnical, engineering, and construction design and testing information to determine original pipeline bending and compression/elongation capabilities at the fault crossings. Secondly, the evaluation shall include an inspection of the pipeline to determine the degree to which the pipeline has been affected by tectonic creep along the Hayward and Concord fault crossings since installation in the 1970's. This evaluation shall be submitted to the CPUC mitigation monitor. Should this evaluation determine that tectonic creep has rendered the pipeline unable to withstand a major seismic event on the Hayward or Concord fault, or to withstand the further seismic creep expected along the two faults during the expected operating lifetime of the pipeline, SPBPC shall undertake repair or modification of the pipeline accordingly, and submit documentation to the CPUC mitigation monitor showing these repairs or modifications have been completed. In accordance with federal regulation (Title 49, Section 195, et al.), the pipeline will be inspected on a regular basis, and immediately following a seismic event or any other event that may effect the safety of the pipeline system or pump station. The findings of these inspections would be reported to the State Fire Marshall, which in California assumes responsibility for enforcement of the above regulations for the federal Department of Transportation.

In addition to the above mitigation measure, remote control isolation valves are installed on either side of the Concord fault crossing, and immediately northwest of the Hayward fault crossing to stop the flow of oil through the pipeline. When the control system detects a significant loss of pressure, as would be the case during a pipeline rupture, these isolation valves would activate and close, thus reducing the fuel oil loss at the rupture. The specially designed concrete conduit encasement of the pipeline at fault crossings, U bends, inspections required through Mitigation Measure VI.1 and remote isolation valves would reduce impacts associated with fault rupture and subsequent pipeline displacement on the Hayward fault or Concord faults.

Significance after mitigation: Less than significant.

a-ii) In the event of an earthquake on any of the aforementioned faults, the pipeline and Hercules Pumping Station would be subject to strong ground shaking. Segments of the pipeline that extend over intertidal marshland sediments, such as Bay Mud, would likely experience the strongest movement because these soft, saturated sediments tend to amplify the ground movement. For example, the pipeline segment that crosses Hastings Slough is likely to experience a greater peak ground acceleration than the a segment supported by bedrock during the same seismic event. The tendency for soft, saturated sediments to amplify ground shaking was observed during the 1989 Loma Prieta earthquake where measured peak ground acceleration in the soft Bay mud and artificial fill sediments near the San Francisco Airport was 0.3 g while the bedrock on Yerba Buena Island measured peak ground acceleration of 0.06 g. The maximum peak ground acceleration recorded during the Loma Prieta event was 0.64 g at the epicenter.

HLA's 1974 geotechnical and seismic study evaluated potential seismic ground motion that could be generated in Bay mud and peat materials underlying Hastings Slough during a major Bay Area earthquake. HLA computed peak ground surface accelerations as high as 0.68 g in the Hastings Slough and recommended that the trestle supporting the pipeline be founded on friction piers driven to depths below the loosely consolidated sediments into more competent and denser sediments. As a result, the segment of the pipeline crossing Hastings Slough, which is most susceptible to amplified ground shaking, is supported by several 65-foot long, 10-inch square precast, prestressed, concrete piles spaced 55 feet apart. This design is expected to tolerate peak ground acceleration and ground movement generated by a characteristic earthquake on the primary active Bay Area faults. In addition, the existing pipeline's design meets the American Petroleum Institute (API) and industry standards that consider effects of seismic ground shaking in the design parameters of fuel and oil facilities. In any major seismic event, ground motion could be excessive and generate movement beyond what some structural elements could tolerate, resulting in minor structural damage such as broken welds, loosened anchoring structures or minor linear distortions to the pipeline itself. This type of damage would be detected during post–earthquake pipeline inspections and repaired in a timely manner to avoid extended delays in pipeline service or in the worse case, pipeline leakage. As mentioned above, remote control isolation valves are installed on either side of the Concord fault crossing, and immediately northwest of the Hayward fault crossing to stop the flow through the pipeline in the event of a major leak caused by earthquake damage. Considering previous seismic and geotechnical evaluation, resulting design and construction of the pipeline and support structures, and safety elements such as isolation valves and routine inspections, the impacts related to potential pipeline rupture due to earthquake ground shaking is reduced to a less than significant level.

Similar to the pipeline, the Hercules Pumping Station is likely to experience strong ground shaking during earthquakes on the Hayward fault or other major Bay Area active faults. Seismic ground shaking could cause damage to operating systems and to structural elements of the pump station resulting in temporary service interruptions. However, because the pump station facility buildings and major pipeline-related equipment was designed to building codes, API, and industry standards in place when it was constructed, major damage resulting in permanent closure of the facility is not anticipated. As would be expected in any major earthquake, building structures could experience minor structural damage, furniture and equipment could topple, or pumping systems may be distressed resulting in minor leakage. Complete structural collapse or major injuries would be less likely at the pumping station given that it was designed and constructed to appropriate building codes and industry standards. The Hercules Pump Station is equipped with a secondary containment system for all above-ground storage tanks, so in the unlikely event of a tank rupture resulting from seismic ground shaking or other ground failure, tank contents would be captured to avoid leakage into the environment. Although the potential for seismic ground shaking to occur at the pumping station is unavoidable, the risk of excessive, permanent damage or major injury to workers is anticipated to be relatively minor, therefore, ground shaking hazards are considered less than significant. The 4,000-foot pipeline replacement section would be located in an area subject to strong seismic ground shaking. Similar to the existing pipeline segments and facilities described above, the 4,000-foot replacement segment could be subjected to damage occurring as a result of a major seismic event. Significant damage resulting in pipeline rupture or long-term service interruptions would occur if the seismic event generated ground motions exceeding what the pipeline and support structure could tolerate. While complete pipeline failure is not anticipated, seismic ground motion could cause damage requiring temporary service disruption, and post-earthquake inspections. Damage could include broken welds or minor linear distortion. Seismic ground shaking along the 4,000-foot replacement segment is unavoidable but appropriate site evaluation, engineering analysis and structural design, as addressed by Mitigation Measure VI.2 discussed below, could reduce the potential for damage caused by earthquakes.

Impact VI.2: The 4,000-foot pipeline replacement section could be subjected to strong ground shaking during a seismic event, potentially resulting in pipeline rupture or long-term service interruption.

Mitigation Measure VI.2: Prior to commencing construction activities, the new owner (SPBPC) shall prepare a geotechnical report for the 4,000-foot replacement route in Martinez that includes an analysis of ground shaking effects, liquefaction potential, earthquake-induced settlement, and other seismic hazards and provide recommendations to reduce these hazards. The geotechnical and seismic evaluation shall be conducted by a California-registered geotechnical engineer and include appropriate evaluation of anticipated ground motion using currently accepted seismic parameters and methods. Subsurface exploration and soil testing, where appropriate, shall be conducted to assess the soil and bedrock conditions along the proposed pipeline easement. Where applicable, structural and seismic design parameters shall conform to the current Uniform Building Code (UBC) and the API standards. The results of the geotechnical evaluation shall be submitted to the CPUC mitigation monitor. Based on the geotechnical study, recommendations of the geotechnical engineer shall be incorporated into the design and construction of the pipeline segment. In addition to complying with all applicable local, state, and federal policies, codes, and regulations, SPBPC shall submit documentation to the CPUC mitigation monitor showing these recommendations were implemented.

Significance after mitigation: Less than significant.

The pipeline is likely to be susceptible to liquefaction hazards in locations where the pipeline crosses estuarine soils with high water table conditions, such as through portions of Richmond and in Hastings Slough. Liquefaction of sediments could result in settlement or distortion of the pipeline causing substantial damage to the pipeline, particularly in Hastings Slough where the pipeline crosses through marshland. As mentioned above, liquefaction occurs when ground motion suddenly decreases the strength of cohesionless saturated sediments (i.e. sand) by collapsing the grain structure. Hastings Slough is underlain by saturated Bay mud with scattered locations of cohesionless sand that were found to be shallow and somewhat dense, therefore, ground failure due to liquefaction was not considered probable at Hastings Slough (Bechtel, 1974). Review of the soil exploration logs provided in the 1974 HLA report supports the finding that although cohesionless materials are present at relatively shallow depths in the slough, they are underlain by progressively denser cohesive clays (older Bay mud) to the maximum depth explored of about 55 feet. However, if liquefaction were to occur in localized areas in Hastings Slough, it is unlikely to cause ground failure capable of damaging the pipeline because the pipeline is supported by driven piles which extend through the loose, saturated Bay mud and peat deposits, and penetrate the underlying stiff, consolidated clays. The denser cohesive clays provide the friction necessary to support the piers. Given that the pipeline support piers are deep enough not to be affected by liquefaction, impacts related to liquefaction ground failure are considered less than significant.

The Hercules Pumping Station is unlikely to experience liquefaction, due to its foundation on Tertiary formations consisting of hard marine sandstone and shale overlain by soft soils non-marine units, estuarine soils, and engineered artificial fill. Further, because the pumping station site soils and slopes were engineered prior to construction, it is expected that if previous geotechnical site evaluations identified potentially liquefiable soils they were removed and replaced with engineered material prior to construction. The pumping station was constructed in compliance with applicable state and local codes and to API guidelines where appropriate. Liquefaction hazards on the pumping station site are considered less than significant.

Impact VI.3: The 4,000-foot pipeline replacement route in Martinez would be subject to liquefaction hazards.

Mitigation Measure: Incorporation of Mitigation Measure VI.2.

Significance after mitigation: Less than significant.

a-iv) Although the majority of the pipeline is located in flat areas along the shoreline, several parts of Richmond, Pinole, Hercules, Rodeo, Martinez, and Pittsburg are filled reclaimed areas with high landslide potential. In addition, many parts of Crockett and Port Costa are over 26 percent in slope and have inherent slope instability. An assessment of the pipeline route was conducted by HLA prior to pipeline construction for the purpose of identifying areas of potential slope instability. Recommendations were then provided by HLA for relocation of the pipeline to avoid or minimize pipeline susceptibility to slope failure hazards. These recommendations were incorporated into final pipeline routing. In most cases, the pipeline easement is situated on a flat slope cut bench (i.e. railroad right of way) and the pipeline placed at sufficient distance from the slope to avoid potential damage. Appropriate engineering evaluation and the subsequent rerouting of the pipeline away from potentially unstable slopes reduced potential landslide impacts to a less than significant.

The Hercules Pump Station is located on an engineered, artificial slope. Proper slope stability analysis and engineering design can overcome the factors that cause landsliding, such as saturation, oversteepening, or removal of lateral support. Geotechnical materials testing and analysis performed prior to pump station construction included recommendations for slope construction and insured that the factors of safety in the engineered slope were within acceptable design standards and were determined to be capable of supporting the required loads. Based on stability analysis, various engineering elements are then incorporated into design of fill areas and engineered fill slopes. Therefore, considering analysis and design elements were incorporated into the facility design, the potential for slope failure would be considered a less than significant impact at the Hercules Pumping Station.

b) Fuel oil transport and operation of the Hercules pump station would not result in soil erosion or loss of topsoil. Construction activities associated with installation of the pipeline replacement section would involve trenching or boring, and could potentially result in soil erosion if exposed soils were subject to heavy winds or rains. The use of construction best management practices typically implemented as part of construction would minimize potential soil erosion to a less than significant level.

c) See discussion regarding Questions a-iii, a-iv, above.

d) **Impact VI.4: Portions of the 4,000-foot replacement section may be located in areas with expansive soils.**

Soil conditions would be assessed during the geotechnical investigation required by **Mitigation Measure VI.1**. Expansive soil conditions underlying the existing pipeline do not pose a concern because site geologic investigation and site preparation completed prior to construction of the pipeline was sufficient to eliminate or correct soil conditions that would have the tendency to harm the pipeline. Incorporation of geotechnical recommendations for the new 4,000-foot segment would reduce potential impacts associated with expansive soils.

Mitigation Measure: Incorporation of Mitigation Measure VI.1.

Significance after mitigation: Less than significant.

e) The project would not include the installation of septic tanks or alternative wastewater disposal systems.

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