4.7 Geology and Soils

4.7.1 Introduction

This section identifies and evaluates potential impacts related to geology and soils that could result from the Project. Discussed are the physical and regulatory settings, the baseline for determining environmental impacts, the significance criteria used for determining environmental impacts, and potential impacts associated with Project construction and demolition, the transitional phase, and operation and maintenance at the Rodeo Refinery. The Santa Maria Site is addressed to the extent information is available and at a qualitative level of discussion.

The Project also includes the Pipeline Sites—four regional pipelines serving the Santa Maria Site and the Rodeo Refinery. The Santa Maria Site is connected to the Rodeo Refinery by approximately 200 miles of subterranean pipeline, crossing San Luis Obispo, Santa Barbara, Kern, Kings, Fresno, Merced, Stanislaus, San Joaquin, Alameda, and Contra Costa Counties. Phillips 66 proposes to empty and clean the pipelines at existing maintenance access points and to decommission or sell them; they would not be excavated as part of this Project. No physical changes would occur. Therefore, the Pipeline Sites are not further addressed in this section.

4.7.2 Environmental Setting

4.7.2.1 Regional Geology

Contra Costa County

The Rodeo Refinery, including the Carbon Plant, is located in northern Contra Costa County along the southeastern edge of San Pablo Bay. Geologically, this region of California is characterized by a series of northwest-trending mountains and valleys controlled by tectonic folding and faulting. The region has undergone a complex geologic history of folding, faulting, uplift, sedimentation, volcanism, and erosion.

Geologic units of the region consist primarily of 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 softer non-marine units. Bedrock in the general vicinity of the Rodeo Refinery is classified as San Pablo Group sedimentary rocks of the Neroly and Cierbo Formations, which consist of Miocene-age (approximately 23.7 to 5.3 million years ago) marine sandstones interbedded with siltstone, mudstone, and shale (Graymer et al. 1994). Generally, native bedrock is closer to the ground surface in sloped and hilly areas of the region, whereas artificial fill material underlies most flat areas, and thickens substantially along the shoreline of San Pablo Bay at and near the Rodeo Refinery. Unconsolidated alluvial deposits, artificial fill, and estuarine deposits underlie the marginal areas along the San Pablo Bay, Carquinez Straight, and Suisun Bay. Landslides in the region occur in weak, easily weathered bedrock on relatively steep slopes.

San Luis Obispo County

The regional geologic structure surrounding and including the Santa Maria Valley area is complex, as it lies within the structural influence of both the California Coast Ranges and the Transverse Ranges of southern California. The Project site is located in the Santa Maria Valley, at the southwestern edge of the Nipomo Mesa. The Nipomo Mesa and Santa Maria Valley comprise a structural and topographic basin bounded by the Casmalia and Solomon Hills on the south, Pacific Ocean on the west, Edna Hills and Newsom Ridge on the north-northeast, and San Rafael Mountains on the east-southeast. The regional geologic structure is extremely, as it lies within the structural influence of both the California Coast Ranges and the Transverse Ranges of southern California. Older rocks exposed in the bordering ranges are at considerable depth beneath Tertiary and Quaternary rocks. The Tertiary rocks form a series of

west-trending folds. Of these folds, the northern-most forms the basin beneath the Santa Maria and Sisquoc valleys (San Luis Obispo 2014; Worts 1951).

4.7.2.2 Regional Faults and Seismicity

Ground movement during an earthquake can vary depending on the overall magnitude, distance to the fault, focus of earthquake energy, and type of geologic material. The composition of underlying soils, even those relatively distant from faults, can intensify ground shaking. Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments such as artificial fill. For this reason, earthquake intensities can be measured in several ways. The two most common are the intensity (the Richter magnitude) and the observed effects (the Modified Mercalli intensity scale) at a given locality. A less frequently used but still common measure is the Moment Magnitude, which is related to the physical characteristics of a fault including the rigidity of the rock, the size of fault rupture, and movement or displacement across a fault (California Geological Survey [CGS] 2002). Richter magnitude is a measure of the size of an earthquake as recorded by a seismograph at the location of the instrument. Richter magnitudes vary logarithmically, with each whole number step representing a ten-fold increase in the amplitude of the recorded seismic waves.

The Modified Mercalli intensity scale (see Table 4.7-1) is commonly used to measure earthquake damage due to ground shaking. The Modified Mercalli intensity scale values for intensity range from I (earthquake not felt) to XII (damage nearly total); intensities ranging from IV to X could cause moderate to significant structural damage.[39] The intensity of an earthquake will vary over the region of a fault and generally decrease with distance from the epicenter of the earthquake.

In addition, state regulations establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around the surface traces of active faults. Those relevant to the Project are identified below.

Contra Costa County

The San Francisco Bay Area region contains both active and potentially active faults, and is considered a region of high seismic activity.[40] The USGS Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes of Richter magnitude (M) 6.7 or higher occurring in the San Francisco Bay Area within the next 30 years. The result of the evaluation indicated a 72 percent likelihood that such an earthquake event would occur in the Bay Area between 2014 and 2044 (Field et al. 2015).

The 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 4.7-1. In the 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.

Alquist-Priolo fault zones within 10 miles of the Rodeo Refinery include the Hayward Fault, Concord Fault, Rodgers Creek Fault, and the West Napa Fault. A description of the fault locations is included in Table 4.7-2.

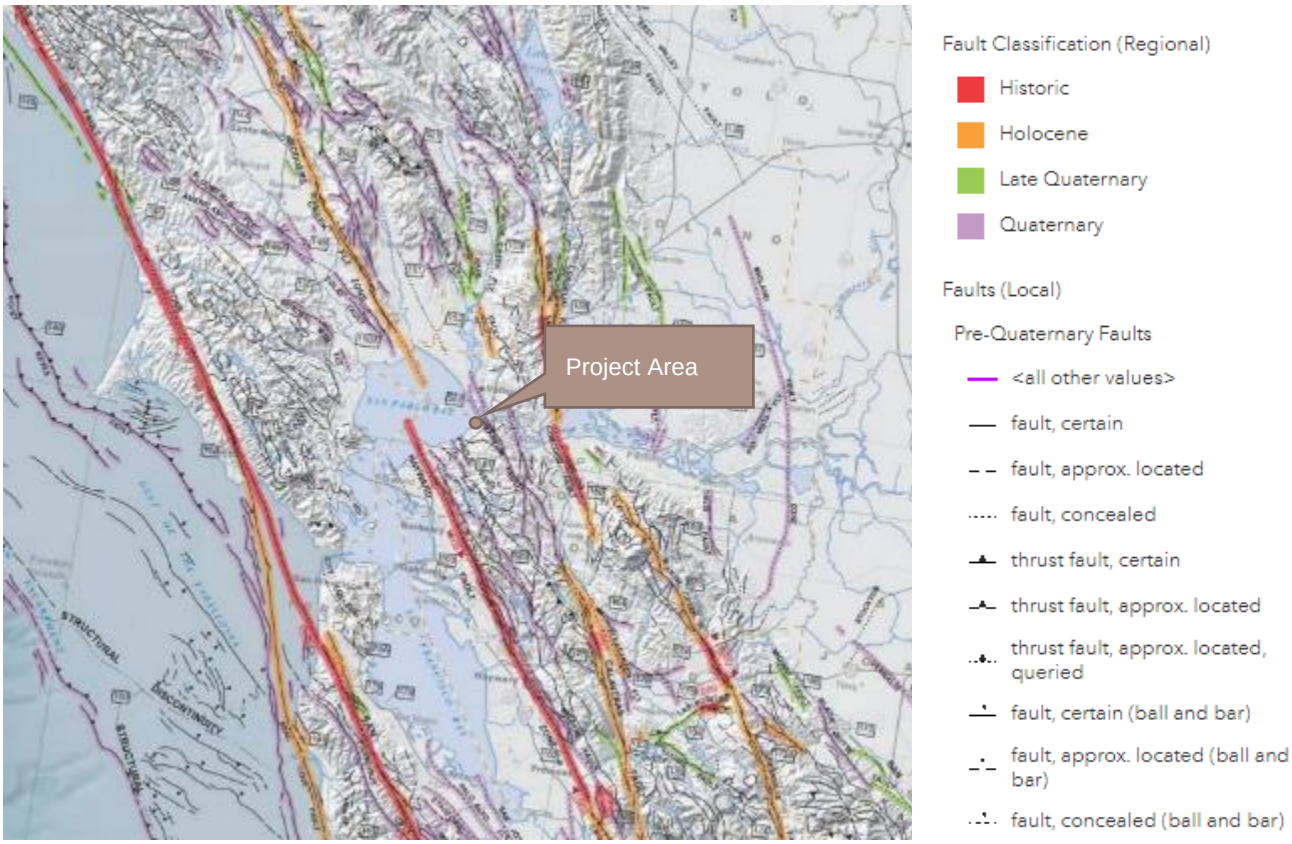
[39] The damage level represents the estimated overall level of damage that will occur for various Modified Mercalli intensity levels. The damage, however, will not be uniform. Not all buildings perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a building all affect its performance.

[40] 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 2007).

San Luis Obispo County

Major active or potentially active faults in the region include the Hosgri, Orcutt-Casmalia, Wilmar Avenue, and Oceano faults. These faults have the potential to generate the greatest strong ground motion in the region; the Orcutt-Casmalia and Hosgri faults have maximum credible earthquakes of magnitude 6.9 and 7.2, respectively (San Luis Obispo County 2014). Other faults in the region include the Los Osos and Lion's Head faults (Dames & Moore 1990).

No Alquist-Priolo fault zones are located within 10 miles of the Santa Maria. The closest Alquist-Priolo Fault Zone to the site is the Los Osos Fault Zone, located near the City of San Luis Obispo, approximately 17 miles to the north-northwest.



Source: CGS (2010)

Figure 4.7-1. Active and Potentially Active Bay Area Earthquake Faults

4.7.2.3 Regional Paleontology

Paleontological resources are the fossilized remains of plants and animals, including vertebrates (animals with backbones), invertebrates (e.g., starfish, clams, ammonites, and marine coral), and fossils of microscopic plants and animals (microfossils). Paleontological resources are most commonly found in undisturbed sedimentary bedrock formations. Artificial fills, which represent disturbed, reworked, and transported materials, would not contain unique or significant paleontological resources.

The Society of Vertebrate Paleontology (SVP) (1995) has established guidelines for the identification, assessment, and mitigation of adverse impacts on nonrenewable paleontological resources. The SVP has helped define the value of paleontological resources and, in particular, indicates that geologic units of high paleontological potential are those from which vertebrate or significant invertebrate or plant fossils have been recovered in the past (i.e., are represented in institutional collections). The sensitivity of an

area with respect to paleontological resources hinges on its geologic setting and whether significant fossils have been discovered in the area or in similar geologic units.

Contra Costa County

A search of the paleontological locality database of the University of California, Museum of Paleontology was conducted to identify vertebrate fossil localities within Contra Costa County (UCMP 2012). The records search did not identify existing fossil localities that directly underlie the Rodeo Refinery. The records search revealed 16 marine and non-marine vertebrate fossil localities that were discovered in the broader region of the San Pablo Group formations. Fossils include extinct genera of horses, cloven-hooved mammals, hares and rabbits, and an extinct genus of elephant. In accordance with SVP criteria, the San Pablo Group formations have a high paleontological potential because vertebrate fossils have been recovered from the formation in the past. All other soils on the site, including artificial fills and geologically recent residuum/alluvium, have a low paleontological potential.

San Luis Obispo County

According to Carson et al. (2020), the general area of the Santa Maria Site contains some formations with moderate to high paleontological potential. These are chiefly Pleistocene alluvial deposits containing a variety of vertebrate fossils and Pliocene-era rocks that have yielded marine mammal and other vertebrate and invertebrate fossils. Most of the area in the immediate vicinity of the Santa Maria Site, however, is characterized by late Holocene streambed, flood plain, and sand dune deposits with little or no paleontological potential.

4.7.2.4 Local Setting

Geology and Soils – Rodeo Refinery

Hillsides in the active area of the Rodeo Refinery have been subjected to extensive cut-and-fill modifications during construction activities from the 1950s and earlier to the present in order to form level areas for the construction of tanks and refining equipment. Subsurface conditions at the Rodeo Refinery generally consist of varying thicknesses of artificial fill materials and native soil over weathered sedimentary rocks. Geotechnical studies confirm that the active refinery components are underlain by an average of 15 feet of artificial fill (i.e., non-native, heterogeneous mixtures of clay, sand, and gravel), which has been graded to a level surface, removing the natural topography of the area (Geomatrix 2002). Native soils, where still present, are fine-textured silt, clay, and sand mixtures that cover underlying bedrock in a thin mantle. Bedrock outcropping is also overlaid by artificial levee fill that resulted from the past cut and fill activities. Areas mapped as artificial levee fill are noted as largely consisting of dumped, uncompacted material when created prior to 1965 (Helley and Graymer 1997). A preliminary geotechnical engineering study performed in 2002 evaluated subsurface conditions at the Rodeo Refinery (Contra Costa County 2003). The investigation determined that the majority of the site is underlain by the Neroly Formation at various depths, which is overlain by unconsolidated native soils and artificial fill. In general, bedrock would be expected to be deeper heading toward the bay shoreline.

Geology and Soils – Santa Maria Site

The Santa Maria Site is located in the Santa Maria Valley, at the southwestern edge of the Nipomo Mesa. The Nipomo Mesa and Santa Maria Valley comprise a structural and topographic basin bounded by the Casmalia and Solomon Hills on the south, the Pacific Ocean on the west, the Edna Hills and Newsom Ridge on the north-northeast, and the San Rafael Mountains on the east-southeast (San Luis Obispo County 2015). Underlying sediments consist primarily of poorly-graded late Quaternary, wind-blown dune sands with limited thin interbeds of silt and clay. These deposits are in turn underlain by late Quaternary

alluvium, Plio-Pleistocene sediments, and/or Pliocene and Miocene age sedimentary rocks (Dames & Moore 1990; Earth Systems Pacific 2008a, 2008b).

Table 4.7-1. Modified Mercalli Intensity Scale

Intensity Value	Intensity Description	Average Peak Ground Acceleration[a]
I	Not felt except by a very few persons under especially favorable circumstances.	< 0.0017 g
II	Felt only by a few persons at rest, especially on upper floors on buildings. Delicately suspended objects may swing.	0.0017–0.014 g
III	Felt noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly, vibration similar to a passing truck. Duration estimated.	0.0017–0.014 g
IV	During the day felt indoors by many, outdoors by few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	0.014–0.039 g
V	Felt by nearly everyone, many awakened. Some dishes and windows broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles may be noticed. Pendulum clocks may stop.	0.035–0.092 g
VI	Felt by all, many frightened and run outdoors. Some heavy furniture moved; and fallen plaster or damaged chimneys. Damage slight.	0.092–0.18 g
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.	0.18–0.34 g
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings, with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.	0.34–0.65 g
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.	0.65–1.24 g
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from riverbanks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.	> 1.24 g
XI	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 1.24 g
XII	Damage total. Practically all works of construction are damaged greatly or destroyed. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown upward into the air.	> 1.24 g

Source: ABAG (2003); USGS (2011)

Notes:

[a] Value is expressed as a fraction of the acceleration due to gravity (g). Gravity (g) is 9.8 meters per second squared. 1.0 g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

Table 4.7-2. Active Faults In the Project Site Vicinity

Fault	Location and Direction from Project Site	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	M 6.8, 1868 Many <M 4.5	7.1
West Napa	8 miles north	Holocene	Active	Not Available	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	M 6.7, 1898 M 5.6, 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	M 7.1, 1989 M 8.25, 1906 M 7.0, 1838 Many <M 6	7.9
Calaveras (northern)	25 miles southeast	Historic (1861 rupture) Holocene	Active	M 5.6-M 6.4, 1861 M 4 to M 4.5 swarms 1970, 1990	6.8
Marsh Creek-Greenville	28 miles southeast	Historic (1980 rupture) Holocene	Active	M 5.6 1980	6.9

Source: Jennings and Bryant (2010); Hart (2007)

Notes:

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 2007).

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, derived from the joint CGS/USGS Probabilistic Seismic Hazard Assessment for the State of California (Peterson et al. 1996).

Faults and Seismicity – Rodeo Refinery

There are no known active faults traversing the Rodeo Refinery. The closest active fault to the Rodeo Refinery is the Hayward fault, located approximately 7 miles southwest. The Hayward Fault Zone is the southern extension of a fracture zone that includes the Rodgers Creek fault (north of San Pablo Bay), the Healdsburg fault (Sonoma County), and the Mayacama fault (Mendocino County). The Hayward fault trends to the northwest within the East Bay, extending from San Pablo Bay in Richmond, 60 miles south to San Jose, where it converges with the Calaveras fault, a similar type of fault that extends north to Suisun Bay. Historically, the Hayward fault generated two sizable earthquakes, both in the 1800s. The USGS Working Group on California Earthquake Probabilities includes the Hayward–Rodgers Creek fault systems in the list of those faults that have the highest probability of generating earthquakes of M 6.7 and greater sometime over the next 30 years (Field et al. 2015).

Other nearby potentially active faults include the Franklin and Southampton faults, although the California Geological Survey (CGS, formerly California Division of Mines and Geology) does not consider the Franklin or Southampton faults to be active, nor are they zoned under the Alquist-Priolo Act as Earthquake Hazard Zones (Hart 2007). The Franklin fault, located 1 mile east of the Rodeo Refinery, extends southwest of Walnut Creek to an inferred terminal point located near the town of Selby along the south shore of the Carquinez Strait. The maximum credible earthquake for the Franklin fault has been estimated to be M 6.5 (Geomatrix 1992 as referenced in Contra Costa County 2003). The Southampton fault, located approximately 2.5 miles east of the refinery, extends northwest across the Carquinez Strait near the town of Port Costa to an inferred terminal point in the low-lying hills east of the city of Vallejo. The maximum credible earthquake for the Southampton fault has been estimated to be M 6.25 (Geomatrix 1992 as referenced in Contra Costa County 2003).

Faults and Seismicity – Santa Maria Site

The Santa Maria Site is located in a geologically complex and seismically active region that is subject to earthquakes and potentially strong ground shaking (San Luis Obispo County 2015). Earthquakes up to magnitude 4.0 commonly occur throughout the region and available historical and instrumental data indicate at least 10 magnitude 5 to 5.5 earthquakes have occurred in the onshore and offshore areas of the site region since 1902. In addition to these local earthquakes, the 1927 Lompoc earthquake (M 7.0), located offshore of Point Arguello, and the 1857 Fort Tejon earthquake (M 7.9), located on the San Andreas Fault, generated significant strong ground motion at the site. More recently, the 2003 San Simeon earthquake (M 6.6) generated strong ground motion in the Project area (USGS 2008).

4.7.2.5 Seismic Hazards

Seismic hazards include ground shaking, liquefaction, lateral spreading, differential settlement, landsliding, and inundation by encroaching waves (tsunami and seiches).

Ground Shaking – Rodeo Refinery

The severity of ground shaking at the Rodeo Refinery resulting from a specific earthquake would depend on the characteristics of the generating fault, distance to the energy source, the magnitude of the event, and the site-specific geologic conditions. The areas of the site directly underlain by bedrock would likely experience less severe ground shaking than those underlain by artificial fill or native soils. According to the CGS probabilistic seismic hazard map, peak ground acceleration[41] (PGA) at the Project site could reach or exceed 0.47 *g* (CGS 2013). A probabilistic seismic hazard map[42] is a map that shows the hazard from earthquakes that geologists and seismologists agree could occur. It is "probabilistic" in the sense that the analysis takes into consideration the uncertainties in the size and location of earthquakes and the resulting ground motions that can affect a particular site. By comparison, the PGAs recorded in San Francisco and Oakland during the 1989 moment magnitude 6.9 Loma Prieta earthquake were approximately 0.3 *g*. However, the recording sites were located over 40 miles from the earthquake epicenter. Ground accelerations within the Loma Prieta epicenter region were 0.7 *g* (CGS 1990). The

[41] Ground accelerations are expressed in terms of *g*, which is equal to the acceleration of gravity, or approximately 32.2 feet per second squared. An object that accelerates at 1 *g* for one second will reach a speed of 32.2 feet per second and cover a distance of 16.1 feet.

[42] The maps are typically expressed in terms of probability of exceeding a certain ground motion. For example, the maps showing 10 percent probability of exceedance in 50 years depict an annual probability of 1 in 475 of being exceeded each year. This level of ground shaking has been used for designing buildings in high seismic areas. These maps show ground motions that geologists and seismologists do not think would be exceeded in the next 50 years; in fact, there is a 90 percent chance that these ground motions would not be exceeded. This probability level allows engineers to design buildings for larger ground motions than geologists and seismologists think would occur during a 50-year interval, which makes buildings safer than if they were only designed for the ground motions that are expected to occur in the next 50 years. Seismic shaking maps are prepared using consensus information on historical earthquakes and faults. These levels of ground shaking are used primarily for formulating building codes and for designing buildings. The maps can also be used for estimating potential economic losses and preparing for emergency response (Peterson et al. 1999).

Rodeo Refinery, which is approximately 75 miles from the epicenter, experienced only 0.1 *g* (Contra Costa County 1994).

Ground Shaking – Santa Maria Site

The predicted PGA at the Santa Maria Site in San Luis Obispo County for a seismic event with a return period of 144 years or less is 0.15 *g* (San Luis Obispo County 2015). That PGA would cause ground shaking corresponding to a Modified Mercalli Intensity VI event, which could result in light damage to infrastructure such as roads, bridges, and pipelines.

Liquefaction

Liquefaction is the sudden temporary loss of shear strength in saturated granular sediments (typically, sands) subjected to ground shaking. It generally occurs when seismically-induced ground shaking causes the pressure of the water between the granules to increase to a point equal to the pressure of the soil overburden. When this occurs, the soil can move like a fluid, hence the term liquefaction. Liquefaction can cause foundation failure of buildings and other facilities due to the reduction of foundation bearing strength. The potential for liquefaction depends on the duration and intensity of earthquake shaking, particle size distribution of the soil, density of the soil, and elevation of the groundwater. Areas at risk due to the effects of liquefaction are typified by a high groundwater table and underlying loose to medium-density granular sediments, particularly younger alluvium and artificial fill.

Rodeo Refinery

Fill and native sediments encountered beneath the Rodeo Refinery during previous geotechnical investigations were predominantly stiff clayey sands and sandy clays with gravel, although layers of loose sands and sandy gravels were present. Shallow groundwater within the upper 50 feet below ground surface was encountered in some borings (Geomatrix 2002 as referenced in Contra Costa County 2003). Previous geologic investigations at the Rodeo Refinery have noted that areas underlain by shallow bedrock are generally not at risk for liquefaction (Contra Costa County 1994). According to the ABAG Liquefaction Susceptibility Map, the majority of the Rodeo Refinery is mapped as having a very low risk of liquefaction (ABAG 2018). The exception is the western shoreline area, where the railcar loading rack and tanker dock components of the Rodeo Refinery are located; that area is characterized as an area of very high liquefaction susceptibility (ABAG 2018).

Santa Maria Site

The Safety Element of the San Luis Obispo County General Plan indicates that locally shallow groundwater and sandy soils have created a moderate potential for liquefaction in the vicinity of the Santa Maria Site (San Luis Obispo County 1999). Site investigations at the Santa Maria Site itself have suggested that groundwater is deeper than approximately 20 feet below the ground surface and that the sands underlying the facility are sufficiently dense to prevent liquefaction at levels of seismically induced ground motion from a large earthquake. However, a recent analysis concluded that shallow groundwater and sandy soils also create a moderate potential for liquefaction at the Santa Maria Site (San Luis Obispo County 2015).

Differential Settlement

Earthquake shaking can produce compaction and densification of dry, uniformly graded, granular, and loose soil material. The amount of compaction across an area can vary due to differences in soil types, producing differential settlement. Artificial fill may also be susceptible to differential settlement. Differential settlement can affect existing and proposed foundations, slabs, and pavements, but the potential for differential settlement is normally accounted for in facility design and construction.

Rodeo Refinery

Geotechnical information from the Rodeo Refinery indicates that differential settlement could occur in some situations (Geomatrix 2002 as referenced in Contra Costa County 2003).

Santa Maria

Shallow groundwater and sandy soils create a moderate potential for liquefaction at the Project Site. Water levels measured in borings drilled at the Project Site, in combination with the proximity of the site to the Oso Flaco Creek floodplain to the south, indicates that high groundwater levels may be seasonally high or under other high water table conditions. Lateral spreading and seismically induced settlement typically occur in association with liquefaction (San Luis Obispo County 2014). Safety Element Map 3 of the San Luis Obispo County General Plan shows the Santa Maria Site as an area with moderate potential for seismic related settlement (San Luis Obispo County 2015).

4.7.2.6 Other Geologic Hazards

Expansive Soil

Expansive soils are fine-grained clay sediments that exhibit a “shrink-swell” behavior in which cyclic changes in volume (expansion and contraction) occur from alternate wetting and drying. Damage to structures on expansive soils may result over an extended period of time, and are manifested as cracking, settlement, and uplift of foundations, paved roads and streets, and concrete slabs.

Rodeo Refinery

According to the engineering study for a previous project at the Rodeo Refinery, existing near-surface soils at several locations have moderate to high expansion potentials (Contra Costa County 2003). The potential for damage from such conditions has been minimized by appropriate soil and foundation engineering during the construction of the existing refinery structures.

Santa Maria Site

Soils at the Santa Maria Site consists of dune sand. Therefore, the likelihood of the presence of expansive soils is low.

Soil Erosion

Soil erosion is the process whereby soil materials are worn away and transported to another area by wind or water. Excessive soil erosion can eventually lead to damage of building foundations and other improvements. Rates of erosion can vary depending on the soil material and structure, soil placement, and human activity, and erosion is most likely on sloped areas with exposed soil, especially when unnatural slopes are created by cut and fill activities.

Rodeo Refinery and Santa Maria Site

Both the Rodeo Refinery and Santa Maria Site have been extensively graded and covered with concrete, structures, asphalt, or vegetation. The soil erosion potential is very low at both sites.

Landslides

A landslide or slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Landslides are dependent on a number of factors, including slope, geology, amount of rainfall, excavation, and seismic activity. Steep slopes and downslope creep of surface materials characterize landslide-susceptible areas.

Rodeo Refinery

The Rodeo Refinery is constructed on a hillside that was historically altered to create flat, terraced building pads. Although regional geologic mapping identified fill within the Rodeo Refinery as being uncompacted, site-specific mapping has not identified landslide prone materials (Contra Costa County 1994).

Santa Maria Site

The Santa Maria Site is located on undulating dune topography, with elevations ranging from approximately 50 to 180 feet above mean sea level (San Luis Obispo County 2015). Slope gradients are predominantly gentle, with localized steep slopes up to 30 feet high where the topography has been modified by grading. Santa Maria Site is constructed on land with gentle slopes (San Luis Obispo County 2015) that would have little or no susceptibility to landsliding.

Natural Settlement

Natural settlement typically occurs in unconsolidated deposits, such as artificial fill and the estuarine deposits locally referred to as Bay Mud, over time as a result of increased foundation loads and vibrations from overlying structures. Natural settlement may affect foundations, slabs, and pavements.

Rodeo Refinery

Geotechnical studies conducted for a previous project at the Rodeo Refinery indicated that areas of the site were susceptible to 1 inch of settlement, depending upon foundation design (Geomatrix 2002 as referenced in Contra Costa County 2003).

Santa Maria Site

Shallow groundwater and sandy soils create a moderate potential for liquefaction at the Project Site. Water levels measured in borings drilled at the Project Site, in combination with the proximity of the site to the Oso Flaco Creek floodplain to the south, indicates that high groundwater levels may be seasonally high or under other high water table conditions. Safety Element Map 3 of the San Luis Obispo County General Plan shows the Santa Maria Site as an area with moderate potential for settlement (San Luis Obispo County 2015).

Paleontology

Rodeo Refinery

Hillsides in the developed area of the Rodeo Refinery have been subjected to extensive cut-and-fill excavation during past construction activities. Grading and fill took place in the 1950s and earlier to form level areas for the construction of tanks and refining equipment. Subsurface conditions generally consist of varying thicknesses of artificial fill materials and native soil over weathered sedimentary rocks. Paleontological resources are most commonly found in undisturbed sedimentary bedrock formations. Artificial fills would not contain unique or significant paleontological resources: any fossils originally present would likely have been damaged or destroyed beyond recognition, and most modern artificial fills are imported from younger unconsolidated alluvium that is usually too young to have fossilized the remains of organisms.

Santa Maria Site

There are no known paleontological resources or unique geologic formations or sites located within the Santa Maria Site (San Luis Obispo County 2015).

4.7.2.7 Regulatory Setting

Federal Regulations

Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act was enacted in 1997 to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program." To accomplish this, the Act established the National Earthquake Hazards Reduction Program (NEHRP). This program was significantly amended in November 1990 to refine the description of agency responsibilities, program goals, and objectives.

The NEHRP's mission includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improvement of building codes and land use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improvement of mitigation capacity; and accelerated application of research results. The NEHRP designates the Federal Emergency Management Agency (FEMA) as the lead agency of the program and assigns it with several planning, coordinating, and reporting responsibilities. Programs under NEHRP help inform and guide planning and building code requirements such as emergency evacuation responsibilities and seismic code standards.

Occupational Safety and Health Administration Regulations

Excavation and trenching are among the most hazardous construction activities. The Occupational Safety and Health Administration's (OSHA's) Excavation and Trenching standard (29 CFR Section 1926.650) covers requirements for excavation and trenching operations. OSHA requires that all excavations in which employees could potentially be exposed to cave-ins be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

State Regulations

California Building Code

The California Building Code (CBC) has been codified in the as CCR Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which by law is responsible for coordinating and centralizing all building standards. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety, and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, CBC Chapter 16, Section 1613, provides earthquake loading specifications for every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, which shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7-05.

CBC Chapter 18 covers the requirements of geotechnical investigations (Section 1803), excavation, grading, and fills (Section 1804), load-bearing of soils (1805), as well as foundations (Section 1808), shallow foundations (Section 1809), and deep foundations (Section 1810). Chapter 18 also describes analysis of expansive soils slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading. It also addresses measures to be considered in structural design to minimize potential hazards.

Chapter 33 of the California Building Code contains specific requirements pertaining to site demolition, excavation, and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapter 70 of the California Building Code regulates grading activities, including drainage and erosion control. Construction activities are subject to occupational safety standards for excavation, shoring, and trenching, as specified in California Occupational Health and Safety Administration (CCR Title 8) and in Section A33 of the California Building Code.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. Under this Act, seismic hazard zones are mapped by the State Geologist to assist local governments in land use planning. Section 2691(c) of the Act states that "it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety." Section 2697(a) of the Act states that "cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard."

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures used for human occupancy. The main purpose of the Act is to prevent the construction of buildings used for human occupancy on top of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as ground shaking or landslides. The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around the surface traces of active faults, and to issue appropriate maps. A trace is a line on the earth's surface defining a fault. Wherever an active fault exists, if it has the potential for surface rupture, a structure for human occupancy cannot be placed over the fault and must be a minimum distance from the fault (generally 50 feet). An active fault, for the purposes of the Alquist-Priolo Act, is one that has ruptured in the last 11,000 years. Maps are then distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Generally, construction within 50 feet of an active fault zone is prohibited.

State Water Resources Control Board Construction General Permit

The California Construction Storm Water Permit (Construction General Permit),[43] adopted by the SWRCB, regulates construction activities that include clearing, grading, and excavation resulting in soil disturbance of at least one acre of total land area. The Construction General Permit authorizes the discharge of storm water to surface waters from construction activities. It prohibits the discharge of materials other than storm water and authorized non-storm water discharges and all discharges that contain a hazardous substance in excess of reportable quantities established at 40 CFR Section 117.3 or 40 CFR Section 302.4 unless a separate NPDES Permit has been issued to regulate those discharges.

The Construction General Permit requires that all developers of land where construction activities will occur over more than 1 acre do the following:

- Complete a Risk Assessment to determine pollution prevention requirements pursuant to the three Risk Levels established in the General Permit;
- Eliminate or reduce non-storm water discharges to storm sewer systems and other waters of the Nation;

[43] *General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities,* Order No. 2009-0009-DWQ, as amended by Order No. 2010-0014-DWQ and 2012-0006-DWQ, National Pollutant Discharge Elimination System No. CAS000002.

- Develop and implement a Storm Water Pollution Prevention Plan (SWPPP), which specifies BMPs that would reduce pollution in storm water discharges to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology standards; and
- Perform inspections and maintenance of all BMPs.

Typical BMPs contained in SWPPPs are designed to minimize erosion during construction, stabilize construction areas, control sediment, control pollutants from construction materials, and address post construction runoff quantity (volume) and quality (treatment). The SWPPP must also include a discussion of the program to inspect and maintain all BMPs.

Local Regulations

Contra Costa County General Plan

Contra Costa County has established goals, policies, and programs in regard to geologic hazards. These are outlined in the Conservation and Safety Elements of the county general plan (Contra Costa County 2010). The policies and programs that may be directly applicable to the Project are as follows:

- **Policy 10-4:** In areas prone to severe levels of damage from ground shaking (i.e., Zone IV on map 10-4 of the general plan), where the risks to life and investments are sufficiently high, geologic-seismic and soils studies shall be required as a precondition for authorizing public or private construction.
- **Policy 10-5:** Staff review of application for development permits and other entitlements, and review of applications to other agencies that are referred to the County, shall include appropriate recommendations for seismic strengthening and detailing to meet the latest adopted seismic design criteria.
- **Policy 10-9:** In areas susceptible to high damage from ground shaking (i.e., Zone IV on map 10-4 of the general plan), geologic-seismic and soils studies shall be required prior to authorization of major land developments and significant structures (public or private).
- **Policy 10-10:** Policies regarding liquefaction shall apply to other ground failures which might result from ground shaking, but which are not subject to such well-defined field and laboratory analysis.
- **Policy 10-20:** Any structures permitted in areas of high liquefaction danger shall be sited, designed and constructed to minimize the dangers from damage due to earthquake-induced liquefaction.
- **Policy 10-21:** Approvals to allow for the construction of public and private development projects in areas of high liquefaction potential shall be contingent upon geologic and engineering studies which define and delineate potentially hazardous geologic and/or soils conditions, recommend means of mitigating these adverse conditions, and on proper implementation of the mitigation measures.
- **Policy 10-27:** Soil and geological reports shall be subject to the review and approval of the County Planning Geologist.
  - **Implementation Measure 10-d:** Through the environmental review process, require geologic, seismic, and/or soils studies as necessary to evaluate proposed development in areas subject to ground shaking, fault displacement, or liquefaction.

San Luis Obispo County General Plan

The Safety Element of the San Luis Obispo County General Plan provides measures for evaluation of geologic hazards and geotechnical requirements related to new construction to reduce the potential for loss of life and reduce the amount of property damage including:

- **Policy S-18 Fault Rupture Hazards:** Locate new development away from active and potentially active faults to reduce damage from fault rupture. Fault studies may need to include mapping and exploration beyond project limits to provide a relatively accurate assessment of a fault's activity. The County will enforce applicable regulations of the Alquist-Priolo Earthquake Fault Zoning Act pertaining to fault zones to avoid development on active faults.
  - **Implementation Measure Standard S-49:** The County will continue to enforce elements of the general plan, based on the Alquist-Priolo Earthquake Fault Zoning Act, that require geologic studies to be performed so that habitable structures and essential facilities will be sited away from active and potentially active faults.
- **Policy S-19 Reduce Seismic Hazards:** The County will enforce applicable building codes relating to the seismic design of structures to reduce the potential for loss of life and reduce the amount of property damage.
  - **Implementation Measure Program S-50:** Enforce applicable building code regulations pertaining to the design of structures and grading relative to seismic hazards.
  - **Implementation Measure Program S-51:** Adopt new Uniform Building Code requirements, when necessary, to promote the use of updated design standards.
  - **Implementation Measure Program S-52:** Encourage investigations to improve the existing characterizations of faults in areas of existing or proposed development, and their potential to generate damaging earthquakes, for the purpose of assisting in the design of structures to resist seismic loads. Implement appropriate design standards and building codes that address local seismic conditions
- **Policy S-20 Liquefaction and Seismic Settlement:** The County will require design professionals to evaluate the potential for liquefaction or seismic settlement to impact structures in accordance with the currently adopted Uniform Building Code.
  - **Implementation Measure Standard S-53:** Amend the Land Use Element/LCP as needed to incorporate medium to high liquefaction hazard areas identified in the Technical Background Report within the Geologic Study Area by combining designations.
  - **Implementation Measure Standard S-54:** The County will enforce current building code requirements that require the potential for liquefaction to be addressed in the design of structures.
  - **Implementation Measure Standard S-55:** The County will require geotechnical studies to be performed for habitable or important structures (as defined by the building code) sited in areas having moderate to high liquefaction potential as defined in Table 4-15 of the Technical Background Report. The geotechnical study should evaluate the potential for liquefaction and/or seismic related settlement to impact the development, and mitigation to reduce these potential impacts, if needed.
- **Policy S-21 Slope Instability:** The County acknowledges that areas of known landslide activity are generally not suitable for residential development. The County will avoid development in areas of known slope instability or high landslide risk when possible, and continue to encourage

that developments on sloping ground use design and construction techniques appropriate for those areas.

- **Implementation Measure Standard S-56:** For developments in areas of known slope instability, landslides, or slopes steeper than 20 percent, the stability of slopes shall be addressed by registered professionals practicing in their respective fields of expertise. For subdivisions, such studies should be performed prior to delineating lot lines and building envelopes.
- **Implementation Measure Standard S-57:** New development will not be permitted in areas of known landslide activity unless development plans indicate that the hazard can be reduced to a less-than-significant level prior to beginning development.

4.7.3 Significance Criteria

Based on CEQA Guidelines Appendix G, a project would cause adverse impacts related to geology and soils if it would:

a. Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving:

b. 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 California Department of Conservation, Division of Mines and Geology Special Publication 42;

c. Strong seismic ground shaking;

d. Seismic-related ground failure, including liquefaction;

e. Landslides;

f. Result in substantial soil erosion or the loss of topsoil;

g. 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 onsite or offsite landslides, lateral spreading, subsidence, liquefaction or collapse;

h. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (International Conference of Building Officials 1994), creating substantial risks to life or property;

i. Have soils incapable of adequately supporting the use of septic tanks or alternative waste disposal systems where sewers are not available for the disposal of wastewater; or

j. Directly or indirectly destroy a unique paleontological resource or site or unique geological feature.

4.7.4 CEQA Baseline

Baseline conditions reflect the 2019 operation and maintenance of the Rodeo Refinery and Santa Maria Site as petroleum refineries, including operation and maintenance activities. The baseline setting also includes the applicable regulatory framework to protect environmental resources, which are described above.

4.7.5 Approach to Analysis

Continuing operation and maintenance of the Rodeo Refinery does not involve any new activities that could expose personnel to risks associated with geology and soils. Therefore, operation and maintenance impacts associated with the Rodeo Refinery are not further addressed, and the focus of analysis is on construction of new facilities and demolition impacts.

The transitional phase of the Project does not involve activities that would be affected by risks associated with geology and soils above that identified for construction/demolition impacts. Therefore, the transitional phase is not further addressed.

4.7.6 Discussion of No Geology and Soils Impacts

Review and comparison of the setting circumstances and proposed Project characteristics with the significance criteria stated above, clearly indicate that no impacts would be associated with criteria a.-i. and a.-iv., e, and f. The following discusses the reasoning to support this conclusion.

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; and

The closest active fault to the Rodeo Refinery is the Hayward fault, located approximately 7 miles to the southwest. The Concord/Green Valley Fault is located approximately 8 miles to the northeast. The Rodeo Refinery is located between these two active, Alquist-Priolo zoned faults, but is far enough away from each one to not be included within either Alquist-Priolo zone. Although fault rupture is not necessarily limited to areas that coincide with the mapped fault trace, the site is sufficiently far enough away from the nearest active fault to be considered not at risk of fault rupture. Therefore, no impacts would occur related to exposure of people to increased risk due to ground rupture during construction/demolition and operation and maintenance. The Contra Costa County General Plan characterizes the Rodeo Refinery as primarily Lowest Damage Susceptibility except for some isolated areas near the bay which have Moderate Damage Susceptibility from seismic ground response.

No active or potentially active faults underlie the Santa Maria Site. The closest Alquist-Priolo Fault Zone to the site is the Los Osos Fault Zone, located near the City of San Luis Obispo, approximately 17 miles to the north-northwest. This is considered far enough away that to be not at risk for surface fault rupture. Therefore demolition of the Santa Maria Site would not expose people or structures to increased risk due to ground rupture, and no impact would occur.

iv. Landslides

The Rodeo Refinery is constructed on flat, terraced building pads. Site-specific mapping has not identified landslide prone materials, and the specific Project component sites are relatively flat. The Santa Maria Site is constructed on flat or gently rolling topography that is not at risk of landslides, and no landslide-prone conditions have been identified on the site. No activities would take place that could expose people or structures to increased risk of landslide at the Rodeo Refinery or Santa Maria Site. Therefore, no impacts would occur related to landslides.

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.

The Project does not include septic tanks or alternative wastewater disposal systems at either the Rodeo Refinery or Santa Maria Site. Control of wastewater is through the existing wastewater collection, treatment, and disposal systems at the Rodeo Refinery. Such systems would be removed as part of demolition of the Santa Maria Site. Therefore, no impact would occur related to the use of septic tanks for alternative wastewater disposal systems.

f. Directly or indirectly destroy a unique paleontological resource or site or unique geological feature.

The Rodeo Refinery and Santa Maria Site are intensively-developed industrial facilities that have been extensively graded and excavated over the past century. The Project would involve construction and demolition at the Rodeo Refinery and Santa Maria Site. No construction would take place on soils or rock formations with a paleontological potential per SVP guidelines. Therefore, there is no potential for encountering in-situ paleontological resources or unique geological formations, and no impact would occur.

4.7.7 Direct and Indirect Impacts of the Proposed Project

Direct impacts result from land modification directly and immediately caused by the construction, operation, or maintenance of a facility. Indirect impacts also occur as a result of a specific project, but do not result from intentional ground disturbance. Common indirect impacts include erosion, vibration, unauthorized artifact collecting, and vandalism. The proposed Project entails ground disturbance construction and demolition activities at the Rodeo Refinery and Santa Maria Site. Review and comparison of the setting circumstances and proposed Project characteristics with the significance criteria above, indicate potential impacts associated with criteria a (ii and iii), b, c, and d. The following discusses these potential impacts.

Table 4.7-3 presents a summary of the potential [env. resource] impacts, as well as significance determinations for each impact.

Table 4.7-3. Summary of Impacts

Impact	Significance Determination		
	LTS	LTSM	SU
Impact 4.7-1. Strong Seismic Shaking			
Rodeo Refinery and Santa Maria Site			
Construction/Demolition Including Transitional Phase[a]		✓	
Rodeo Refinery			
Operation and Maintenance		✓	
Impact 4.7-2. Soil Erosion or loss of top soil			
Rodeo Refinery and Santa Maria Site			
Construction/Demolition Including Transitional Phase[a]	✓		
Impact 4.7-3. Seismic-related ground failure, including liquefaction			
Rodeo Refinery and Santa Maria Site			
Construction/Demolition Including Transitional Phase[a]	✓		
Impact 4.7-4. Located on expansive Soils			
Rodeo Refinery and Santa Maria Site			
Construction/Demolition Including Transitional Phase[a]	✓		

Notes: LTS = Less than significant, no mitigation proposed
LTSM = Less-than-significant impact with mitigation
SU = Significant and unavoidable

[a.] Transitional phase applies only to Rodeo Refinery

IMPACT 4.7-1

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

ii. Strong seismic ground shaking.

Construction/Demolition, Operation and Maintenance: Less-than-Significant Impact with Mitigation

Rodeo Refinery

Strong ground shaking from earthquakes generated by active faults in the Bay Area is a potential hazard to the Project at the Rodeo Facility. During the life of the Project, the Rodeo Facility is likely to be subjected to at least one moderate to severe earthquake that would cause strong ground shaking. According to USGS, the area will likely experience at least one major earthquake (i.e., greater than M 6.7) within the next 30 years. The intensity of such an event would depend on the causative fault and the distance to the epicenter, the moment magnitude, and the duration of shaking. The closest active fault to the Rodeo Refinery is the Hayward fault. Potential damage at the Rodeo Refinery from a significant earthquake on the Hayward fault could include broken piping, piping supports, damaged tanks, and stressed support bolts, but the overall direct damage has been predicted to be minimal, according to a planning study conducted by the California Geologic Survey (formerly California Department of Conservation, Division of Mines and Geology [1987]). Damage at refineries located east of the Hayward fault, as is the Rodeo Refinery, would reportedly be less severe than those west of the Hayward fault (California Department of Conservation, Division of Mines and Geology 1987). Damage from a significant earthquake on Rodgers Creek fault is predicted to be similar to that of the Hayward fault with only minimal direct damage, considering the vast number of structures, tanks, and pipelines associated with a refinery (California Department of Conservation, Division of Mines and Geology 1994).

Refineries are complex facilities and are, in general, conservatively designed and constructed. They consist not only of conventional buildings, but also structures that are unique to the petroleum refinery process. Over time, refineries undergo modifications and additions. Each phase of modification may be constructed by different groups and may occur over many years. Because seismic design standards have changed considerably over the last several decades, the seismic resistance of a given refinery may vary with the age of construction, with the newest structures and process equipment expected to perform best.

Foundation and structural designs that can withstand the level of ground shaking that could occur at the Project Site are in common use today. In accordance with the CBC, project equipment would be designed, at minimum, to withstand the ground acceleration that has a 10 percent probability of being exceeded in 50 years.[44] With foundation and structural design in accordance with the current CBC standards, seismic shaking should not result in significant structural damage to the Rodeo Facility. Seismic design consistent with current professional engineering and refinery industry standards would be employed in the proposed construction for resistance to strong ground shaking, especially for lateral forces. In the course of the final facility design, the project engineering geologist or geotechnical engineer may provide additional foundation design recommendations based on the ground conditions at the Rodeo Refinery. These recommendations would become part of the Project specifications.

Appropriate grading and design, in accordance with the CBC requirements and local planning and building department requirements, would be used to reduce the secondary effects of ground shaking on structures and infrastructure. Any fill materials would be appropriately compacted and engineered

[44] CGS peak ground accelerations for the region encompassing the refinery are estimated to reach or exceed 0.46 g for firm rock conditions to 0.53 g for alluvium conditions (CGS 2003).

as directed by the California certified engineering geologist or geotechnical engineer assigned to the Project.

A design-level geotechnical investigation is required for each Project component site area. Each investigation would include an analysis of expected ground motions at the site from known active faults. The analyses would be in accordance with applicable County ordinances and policies and consistent with the most recent version of the CBC, which requires structural design that can accommodate ground accelerations expected from known active faults. The investigations would determine final design parameters for the earthwork, foundations, foundation slabs, and any surrounding related improvements (e.g., utilities, roadways, parking lots and sidewalks). The investigations would be reviewed and approved by a certified engineering geologist or geotechnical engineer.

Implementation of Mitigation Measure GEO-1, which addresses the above-referenced requirements, would reduce impacts to less than significant.

Mitigation Measure GEO-1: Comply with Geotechnical Report

Phillips 66 shall comply with and implement all of the following measures designed to reduce potential substantial adverse effects resulting from strong seismic ground shaking:

- A California licensed geotechnical engineer or engineering geologist shall perform a comprehensive geotechnical investigation of all Project facilities at least 45 days prior to issuance of a grading or building permit. The investigation will be based on adequate subsurface exploration, laboratory testing of selected samples, and engineering/geologic analysis of the data gathered. The information shall be compiled and presented as a geotechnical report that provides an evaluation of potential seismic and geologic hazards, including secondary seismic ground failures, and other geologic hazards, such as landslides, expansive and corrosive soils, and provides current CBC seismic design parameters, along with providing specific standards and criteria for site grading, drainage, berm, and foundation design. The report shall be submitted with the current review fee to the County Peer-Review Geologist for review and approval.
- For construction requiring excavations, such as foundations, appropriate support and protection measures shall be implemented to maintain the stability of excavations and to protect construction worker safety. Where excavations are adjacent to existing structures, utilities, or other features that may be adversely affected by potential ground movements, bracing, underpinning, or other methods of support for the affected facilities shall be implemented.
- Recommendations in the approved geotechnical report shall be incorporated into the design and construction specifications and shall be implemented during build-out of the Project.
- The Project geotechnical engineer shall provide observation and testing services during grading and foundation-related work, and shall submit a grading completion report to the County prior to requesting the final inspection. This report shall provide full documentation of the geotechnical monitoring services provided during construction, including the testing results of the American Society for Testing and Materials. The Final Grading Report shall also certify compliance of the as-built Project with the recommendations in the approved geotechnical report.

IMPACT 4.7-2

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

Construction/Demolition: Less Than Significant, No Mitigation Proposed

Construction of the Project, including during the transitional phase, would require earthwork and grading, which would expose soil and potentially subject it to wind and water erosion. The extent of erosion that could occur would vary depending on soil type, slope steepness and stability, vegetation/cover, and weather conditions.

Rodeo Refinery

Previous work at the Rodeo Refinery indicates that soils at the site are susceptible to erosion. Water- and wind-induced erosion could occur during the construction phase of the Project when concrete and asphalt are removed and soils are stockpiled and exposed.

Santa Maria Site

Demolition activities at the Santa Maria Site would remove concrete, asphalt, and other ground cover, and would involve a certain amount of excavation. These activities would expose soils that are susceptible to erosion to the potential effects of wind and rain.

The Project is required by County ordinance (San Luis Obispo County Chapter 23.05, Contra Costa County Chapter 716-8) as well as through the NPDES General Construction Permit administered by the state to establish erosion control measures for construction activities. The Erosion Control Plan would include, at a minimum, the following requirements:

- Excavation and grading activities would be scheduled for the dry season (April 15 to October 15) to the extent possible. This would reduce the chance of severe erosion from intense rainfall and surface runoff, as well as the potential for soil saturation.
- Temporary erosion control measures would be provided until re-vegetation is established or impervious surfaces (e.g., asphalt, concrete) are added.
- After completion of grading, erosion protection would be provided on all cut-and-fill slopes.
- Erosion control BMPs selected and implemented for the proposed Project would be in place and operational prior to the onset of major earthwork on the site.

Implementation of the Erosion Control Plan and required BMPs as part of the NPDES General Construction Permit would minimize erosion impacts during construction and reduce the potential impacts to less than significant.

Mitigation Measure: **None Required**

IMPACT 4.7-3

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

iii. Seismic-related ground failure, including liquefaction

c. Would the proposed project 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 onsite or offsite landslide, lateral spreading, subsidence, liquefaction or collapse.

Construction/Demolition: Less Than Significant, No Mitigation Proposed

Rodeo Refinery

As discussed above in Impact 4.7-1, a design-level geotechnical investigation would be performed for each Project component site area. Each investigation would include an analysis of the underlying soil properties including the potential for instability, subsidence, liquefaction, or collapse. In the course of final design, the area of the proposed railcar loading rack at the Rodeo Site would be explored by advancing geotechnical borings and/or cone penetration test soundings. The cone penetration tests would provide a nearly continuous profile of soil behavior and engineering characteristics from the ground surface through potentially liquefiable soils until rock or other hard material that is encountered. The cone penetration test soundings would be performed in accordance with the standards of the American Society for Testing and Materials.

Data from the boring and/or cone penetration tests, together with data from existing borings near the site, would be analyzed to evaluate the risk and the consequences of liquefaction. Dynamic stresses induced by earthquake shaking would be estimated and compared to the stresses required to cause liquefaction of the soils beneath the site. The geotechnical report will summarize the liquefaction analysis and provide additional engineering and construction design measures, if needed, to reduce the risk of damage to the proposed improvements from liquefaction.

The analyses would be in accordance with current engineering standards that would effectively mitigate unstable soils. The investigations would determine final design parameters for the earthwork, foundations, foundation slabs, and any surrounding related improvements such as utilities, roadways, parking lots, and sidewalks. The investigations would be prepared by a California registered geotechnical engineer or engineering geologist. The report would be submitted to the Contra Costa County, Department of Conservation and Development, Building Inspection Division for review and approval by engineering staff prior to issuance of construction permits. Therefore, with the application of current required geotechnical design criteria, impacts associated with unstable geologic units or materials would be less than significant.

Santa Maria Site

Activities at the Santa Maria Site would not place structures on soils susceptible to spreading, subsidence, liquefaction, or collapse. Therefore, impacts related to unstable geological conditions would be less than significant.

Mitigation Measure: **None Required**

IMPACT 4.7-4

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

Construction/Demolition: Less Than Significant, No Mitigation Proposed

Rodeo Refinery

The effects of expansive soils could damage foundations of aboveground structures, specifically the proposed PTU at the Rodeo Facility. The expansion and contraction could exert enough pressure on a structure to result in cracking, settlement, and uplift. As stated above, each of the Project components would receive a site-specific geotechnical investigation. As part of these investigations, standard to current engineering practices and required under CBC, each site would be evaluated for potential expansive soils. The final geotechnical report for each site would include recommendations to mitigate any potential hazards associated with expansive soils, if any are present. Therefore, the application of current required geotechnical design criteria would reduce the impact associated with the potential presence of expansive soils to less than significant.

Natural settlement typically occurs in unconsolidated deposits, over time, as a result of increased foundation loads from overlying structures. Differential settlement would be a concern in areas that have been filled with unengineered fill. As discussed above, geotechnical recommendations would include measures such as the proper compaction of subsurface materials and installation of an adequate foundation necessary to minimize potential foundation or structural damage associated with settlement. As discussed earlier, Phillips 66 would be required to submit a design-level geotechnical report to the County in order to obtain grading and building permits. This report would include estimated excavation and fill volumes, compaction standards and methods, and foundation specifications. Compliance with the compaction standards of the American Society for Testing and Materials, the Contra Costa County grading ordinance, and a structural foundation design that incorporates modern engineering standards and that is compliant with the CBC, would ensure that potential settlement hazards-related impacts would be less than significant.

Santa Maria Site

The Santa Maria Site is mapped as Quaternary Dune sands, which are not likely to be expansive as expansive soils typically contain significant amounts of clay. However, the Project would involve demolition activities, and not place any new structures at the Santa Maria Site. Therefore, there would be no risks to life or property associated with the presence of expansive soils at the Santa Maria Site. Impacts would be less than significant.

Mitigation Measure: **None Required**

4.7.8 References

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