3.5

GEOLOGY

3.5.1 Introduction

This section presents the geologic conditions for the proposed Project and its alternatives and analyzes geologic issues including earthquakes, faulting, liquefaction, subsidence, tsunamis, seiches, expansive soils, and mineral resources. This evaluation is based on published reports and the general geologic setting as indicators of potential geologic hazards.

3.5.1.1 Relationship to 1992 Deep Draft Final EIS/EIR

The 1992 Deep Draft Final Environmental Impact Statement/Environmental Impact Report (FEIS/FEIR) evaluated at a project-specific level, and recommended mitigation to the extent feasible for, all significant geological impacts associated with navigation and landfill improvements required to create Pier 400. These include the portions of the current proposed Project located on Pier 400. The Deep Draft FEIS/FEIR also assessed on a general, or programmatic level, the geologic impacts associated with the development and operation of terminal facilities planned for location on Pier 400, including a marine oil terminal and associated infrastructure. The Deep Draft FEIS/FEIR identified the geological resources impacts of terminal development and operation as resulting from 1) liquefaction, 2) fault displacement, 3) slope instability, 4) settlement of existing structures, and 5) flooding. The Deep Draft FEIS/FEIR concluded that geological resources impacts associated with development and operation of terminal facilities planned on Pier 400 due to surface fault rupture, seismically induced ground shaking, and/or tsunami damage, as a result of a large earthquake on a nearby or distant fault, were expected to be significant and unavoidable. The Deep Draft FEIS/FEIR recommended three programmatic mitigation measures to address seismic shaking, liquefaction, surface fault rupture, settlement of new structures and appurtenances, and tsunamis and seiches, including appropriate seismic engineering design based upon extensive site specific geotechnical investigation, an appropriate structural setback from the Palos Verdes Fault Zone, and detailed geotechnical investigations to determine appropriate measures for minimizing settlement to acceptable levels. It was concluded that no feasible mitigation measures could reduce impacts to less than significant levels with respect to surface fault rupture, seismically induced ground shaking, and/or tsunami damage. However, it was concluded that insignificant residual impacts would occur, with respect to liquefaction and soil settlement, as a result of incorporation of these mitigation measures. No other significant impacts related to development on Pier 400 were identified in the Deep Draft FEIS/FEIR.

Mitigation Measures from the 1992 Deep Draft Final EIS/EIR that are Applicable to the Proposed Project

The following Mitigation Measures were developed in the Deep Draft FEIS/FEIR to reduce the significant geologic impacts. These measures remain applicable to the current proposed Project. The following measures would be adopted by the Port of Los Angeles (Port) Board of Harbor Commissioners and would become conditions of proposed Project approval that dictate future development of the proposed Project site:

Mitigation Measure (MM) 4A-4 stated that the proposed terminal facilities would have the potential to experience severe seismically induced ground accelerations. Damage or injury should therefore be minimized through the appropriate seismic engineering design, based upon extensive site-specific geotechnical investigation.

MM 4A-6 stated that detailed geotechnical investigations shall be carried out prior to the final design of structures to be placed on landfills to determine appropriate measures for minimizing settlement to acceptable levels.

Mitigation Measures from the 1992 Deep Draft Final EIS/EIR that are No Longer Applicable or are Not Applicable to the Proposed Project

The following Mitigation Measures were developed in the Deep Draft FEIS/FEIR to reduce the significant impacts to geological resources during construction, but are not applicable to the proposed Project:

MM 4A-1 stated that the stability of both dredge channel side-slopes and landfill containment dikes shall be improved by the establishment of a minimum offset between the two. Flatter channel side-slopes shall be utilized to contribute to greater long-term slope stability as well as slope stability during earthquakes. Adequate offset distances and dredge channel side-slope inclinations shall be determined in accordance with recommendations based on geotechnical investigations and accepted engineering practices during the design phases of the proposed Project.

Reason No Longer Applicable: *The proposed Project does not include dredge channel side-slope engineering. This mitigation measure was incorporated with the original Deep Draft Project and has already been carried out.*

MM 4A-2 stated that the stability of landfill containment dikes shall be improved by removing the upper few feet of surficial bay mud materials from the entire basal area of landfill containment dikes prior to their construction.

Reason No Longer Applicable: *The proposed Project does not include the construction of landfill containment dikes. This mitigation measure was incorporated with the original Deep Draft Project and has already been carried out.*

MM 4A-3 stated that detailed geotechnical investigations shall be carried out prior to the final design of or placement of each landfill and shall include measures for minimizing settlement to acceptable levels if it is determined to pose a threat to future structures.

Reason No Longer Applicable: *No landfilling is required for the proposed Project. This mitigation measure was incorporated with the original Deep Draft Project and has already been carried out.*

MM 4A-5 stated that although the Palos Verdes Fault Zone has not yet been designated by the State of California as "active"…an appropriate structural set-back from the fault zone should be utilized for important structures. Further geologic investigations were underway at the time to better define the boundaries of the Palos Verdes Fault Zone within the Outer Los Angeles Harbor, to identify the structural style of faulting, to define the potential risk of faulting, and to define the potential risk of surface fault rupture.

Reason No Longer Applicable: *This mitigation measure was incorporated with the original Deep Draft Project and has already been carried out. With the exception of the proposed pipeline, no structures are proposed in the vicinity of the Palos Verdes Fault. Therefore, structural set-backs from the fault zone would not be applicable. However, the thickness of the pipe would be increased in the vicinity of the Palos Verdes Hill Fault to accommodate seismic stresses.*

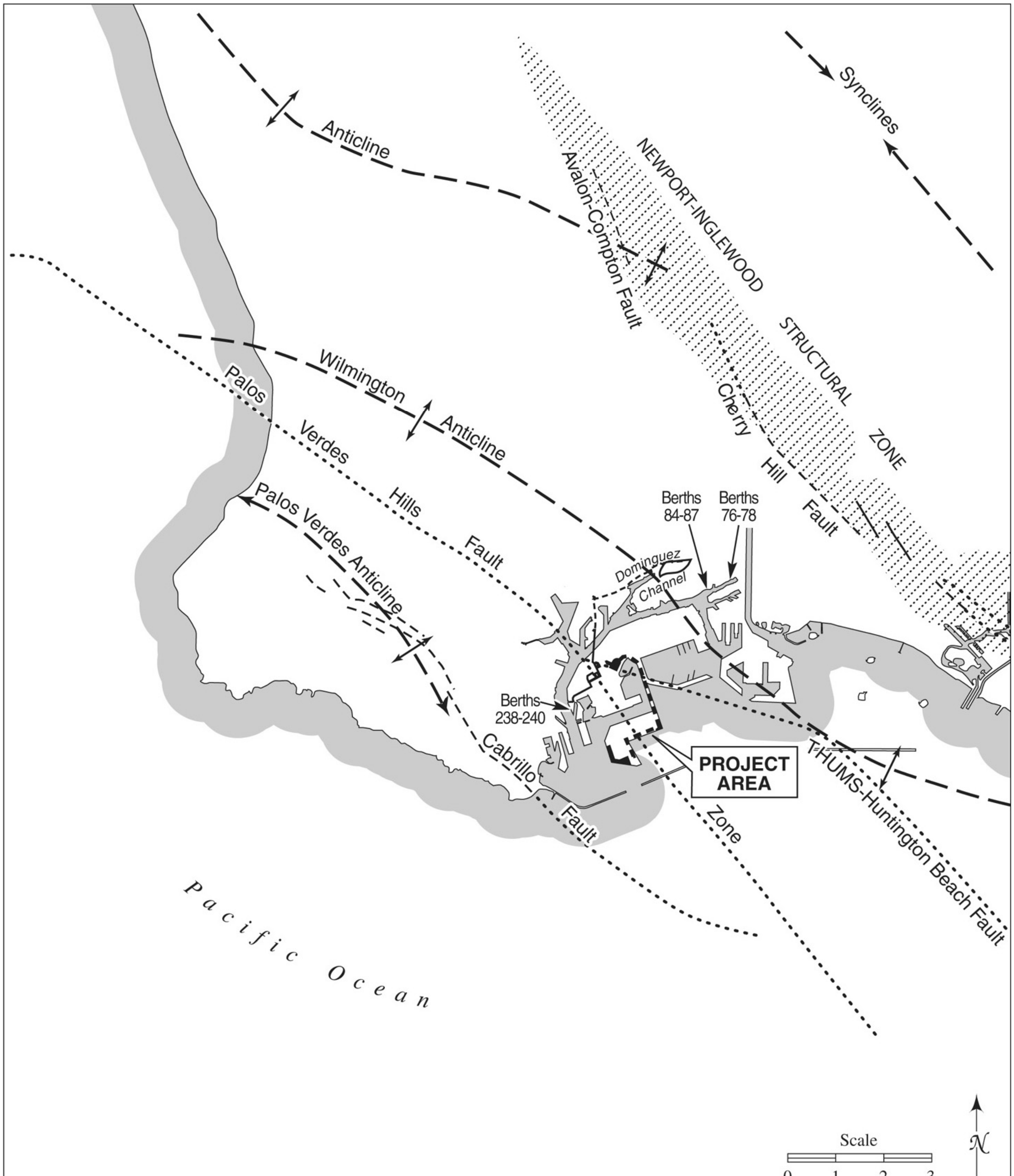
3.5.2 Environmental Setting

3.5.2.1 Regional Setting

Geology

Proposed Project areas include Pier 400, Terminal Island, and Mormon Island, which are manmade islands created during construction of the Port. In addition, the region of analysis includes Los Angeles Harbor Department (LAHD) Berths 238-240, which is similarly located on Terminal Island, and Port of Long Beach Berths 76-78 and 84-87, which are located on hydraulic fills within the flood plain of the nearby Los Angeles River.

The San Pedro Bay Ports are located within the southwestern structural block of the Los Angeles Basin province, one of four such blocks underlying the Los Angeles Basin that are marked by a northwest-southeast trending fault system (Yerkes et al. 1965) (Figure 3.5-1). Varying thicknesses of artificial fill deposits and underlying Pleistocene, Pliocene, and Miocene deposits underlie the proposed Project area (Figure 3.5-2). The alluvial sands and silts underlying the artificial fill were deposited from Recent and Pleistocene river action as outwash from the Los Angeles Basin (Yerkes et al. 1965).



Source: Ninyo & Moore 1992; Fisher et al. 2004

Figure 3.5-1. Local Faults and Geologic Structures – West Los Angeles Basin

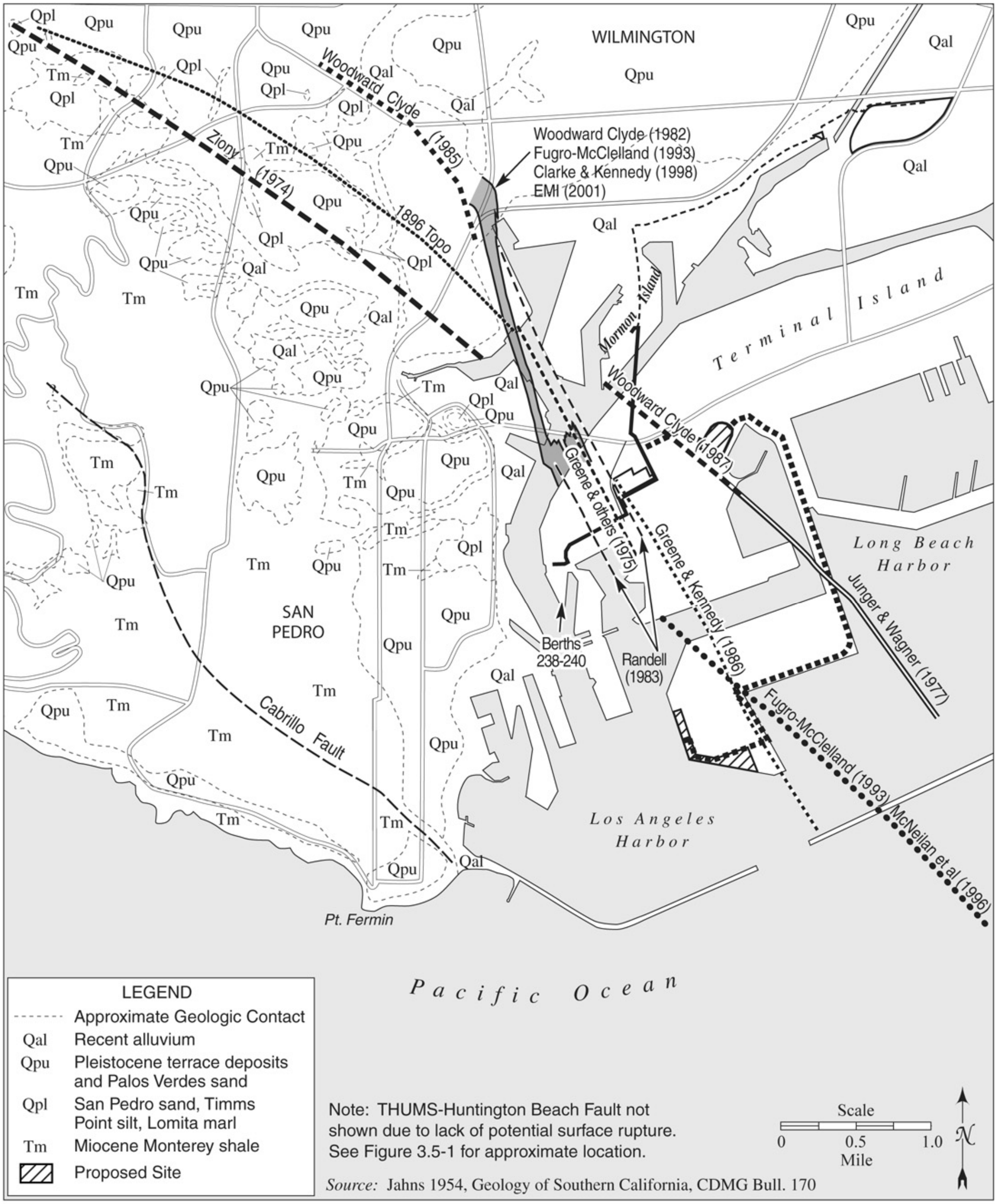


Figure 3.5-2. Palos Verdes Fault Zone – Los Angeles Harbor Area

Earthquakes

Southern California is recognized as one of the most seismically active areas in the U.S. The region has been subjected to at least 52 moderate and major earthquakes of Richter magnitude 6 or greater since 1796. The Richter scale is a logarithmic scale used to express the magnitude of a seismic disturbance (i.e., earthquake) as a range of numerical values that indicate the amount of energy dissipated during the event. Values generally range from 0 to 10. Damage begins at magnitude 4.5 and great earthquakes exceed magnitude 8. Ground motion in the region is generally the result of sudden movements of large blocks of the earth's crust along fault lines. Great earthquakes, like the 1857 San Andreas Fault earthquake (see Table 3.5-1), are quite rare in southern California. Earthquakes of magnitude 7.8 or greater occur at the rate of about two or three per 1,000 years, corresponding to a 6 to 9 percent probability of occurrence in a 30-year period. However, the probability of a magnitude 7.0 or greater earthquake occurring in southern California before the year 2024 is estimated at 85 percent (WGCEP 1995).

Table 3.5-1. Known Earthquakes with Richter Magnitude Greater than 5.5 in the Los Angeles Basin Area

Fault Name	*Date*	*Richter Magnitude*
Palos Verdes Fault	*	*
San Pedro Basin Fault	*	*
THUMS-Huntington Beach	*	*
Santa Monica-Raymond Fault	1855	6.0
San Andreas Fault	1957 1952	8.2 7.7
Newport-Inglewood Fault	1933	6.3
San Jacinto Fault	1968	6.4
San Fernando/Sierra Madre-Cucamonga Fault	1971 1991	6.4 6.0
Whittier-Elsinore Fault Zone	1987	5.9
Camp Rock/Emerson Fault	1992	7.4
Blind thrust fault beneath Northridge	1994	6.6

Source: Ninyo & Moore 1992; U.S. Geological Survey/Caltech 1992 and 1994; Baher et al. 2003.
Note: * No known earthquakes within the last 200 years.

Seismic analyses include discussions of maximum credible and maximum probable earthquakes. A maximum credible earthquake (MCE) is the largest event a fault is believed to be capable of generating. The probability of occurrence is not considered in this characterization. The maximum probable earthquake (MPE) is the largest earthquake to have occurred on a given fault within the last 200 years or is an earthquake that ruptures 0.10 of the total length of the fault. In addition, the LAHD uses a combination of probabilistic and deterministic seismic hazard assessment for seismic design. Probabilistic hazard assessments are required to define two-level design events, including the Operational Level Earthquake (OLE), which is the peak horizontal firm ground acceleration with a 50 percent probability of exceedance in 50 years, and the Contingency Level Earthquake (CLE), which is the peak ground acceleration with a 10 percent probability of exceedance in 50 years.

Fault Zones

Segments of the active Palos Verdes Fault cross the Los Angeles Harbor in the vicinity of the proposed Project areas (Figure 3.5-2). The most recent data regarding the fault in the vicinity of the proposed Project sites was acquired in the Outer Harbor area, prior to construction of Pier 400 (McNeilan, et al. 1996). The location of the fault in this area has been well defined as trending southeast/northwest across the central portion of Pier 400 and Pipeline Segment 1. The location of the fault in other areas of the proposed Project is less well-defined, but two other strands of the fault zone appear to traverse the alignment of the existing and proposed 36-inch pipelines (Pipeline Segments 2a, 2b, and 2c), as well as the ExxonMobil Southwest Terminal. Recent studies indicate that the MCE for the Palos Verdes Fault is Richter magnitude 7.25, with a recurrence interval of 900 years and peak ground accelerations in the Port area of 0.28g and 0.52g, for the OLE and CLE, respectively (EMI 2001, McNeilan et al. 1996).

In addition, the region of analysis includes LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87. The LAHD Berths 238-240 are located less than 0.5 mile west of the fault zone and Port of Long Beach Berths 76-78 and 84-87 are located approximately 3 miles northeast of the fault zone (see Figures 3.5-1 and 3.5-2).

The Los Angeles Harbor is also underlain by the Texaco, Humble, Union, Mobil, and Shell (THUMS)-Huntington Beach Fault. This fault splays southeastward from the Palos Verdes Fault Zone (Figure 3.5-1). Interpretive cross-sections differ on fundamental issues about this fault, in that one interpretation indicates a normal fault that dips east and is downthrown on the east, whereas another interpretation shows that the fault dips west and is downthrown on the west and merges at depth with the Palos Verdes Fault Zone (Fisher et al. 2004). Another interpretation indicates this fault is a large blind thrust fault, which was responsible for uplift of the Wilmington Anticline (Figure 3.5-1). Although the THUMS-Huntington Beach Fault has probably been active during Holocene time, this fault is deeply buried, does not displace Holocene or Pleistocene strata, and is therefore does not pose a surface rupture hazard in the harbor (Edwards et al., 2001; Port of Long Beach 2004). This fault, which has not been included on Figure 3.5-2 due to the lack of potential surface rupture, poses significant seismic hazards to the San Pedro Bay Ports area. However, the extent of the hazard is poorly understood because of the complexity of fault geometries and uncertainties in earthquake locations (Baher et al. 2003).

Numerous other active faults and fault zones are located within the general region, such as the offshore Santa Catalina Fault, the onshore/offshore Newport-Inglewood and Cabrillo faults, and the onshore San Pedro, Whittier-Elsinore, Santa Monica, Hollywood, Raymond, San Fernando, Sierra Madre, Cucamonga, San Jacinto, and San Andreas faults. Table 3.5-2 presents potentially hazardous faults and their associated maximum credible earthquakes in the Los Angeles Basin area.

Table 3.5-2. Hazardous Faults and Earthquake Parameters — Los Angeles Basin Area

Fault Name	*Distance from Sites, miles (km)*	*Maximum Credible Earthquake Magnitude (Greensfelder 1974)* **(EMI 2001)* ***(CEC 2005a)*
Palos Verdes Fault	<1 (<1.6)	7.25*
THUMS-Huntington Beach	<1 (<1.6)	7.0**
Newport-Inglewood Fault	5 (8.0)	7
San Pedro Basin Fault	15 (24.1)	no data
Whittier-Elsinore Fault Zone	22 (35.4)	7.5
Santa Monica-Raymond Fault	23 (37.0)	7.5
San Fernando-Cucamonga Fault	31 (49.9)	6.5
San Jacinto Fault	57 (91.7)	7.5
San Andreas Fault	53 (85.3)	8.25
Santa Catalina Fault	31 (50)	7.0
Cabrillo Fault	2 (3.2)	6.2

Active faults, such as those noted above, are typical of southern California. Therefore, it is reasonable to expect a strong ground motion seismic event during the lifetime of any project in the region. Numerous active faults that do not specifically cross under proposed Project sites are nonetheless capable of generating earthquakes in the proposed Project areas and region of analysis (i.e., LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87) (Table 3.5-1 and 3.5-2). Most noteworthy, due to its proximity to the proposed Project sites and region of analysis, is the Newport-Inglewood Fault, which has generated earthquake magnitudes up to 6.3 on the Richter scale (Guptill and Heath 1981). Large events could occur on more distant faults in the general area, but because of the greater distance from the proposed Project sites and region of analysis, earthquakes generated on these faults may be considered less significant with respect to ground accelerations.

In 1974, the California Division of Mines and Geology (CDMG) was designated by the Alquist-Priolo Act as the agency responsible for delineating those faults deemed active and likely to rupture the ground surface. No faults within the San Pedro Bay Ports area are currently zoned under the Alquist-Priolo Act; however, there is evidence that the Palos Verdes Fault, which lies beneath Pier 400 and other areas within the Port, is active and ground rupture cannot be ruled out (Fischer et al. 1987; McNeilan et al. 1996).

Liquefaction

Liquefaction is defined as the transformation of a granular material from a solid state into a liquefied state as a consequence of increased pore pressure, which results in the loss of grain-to-grain contact. Seismic groundshaking is capable of providing the mechanism for liquefaction, usually in fine-grained, loose to medium density, saturated sands and silts. The effects of liquefaction may be excessive if total and/or differential settlement of structures occurs on liquefiable soils.

Some authors (Tinsley and Youd 1985; Toppozada et al. 1988; Davis et al. 1982) have indicated that the liquefaction potential in the Harbor area during a major earthquake on either the San Andreas or Newport-Inglewood fault is high. The proposed Project site is identified as an area susceptible to liquefaction in the City of Los Angeles General Plan, Safety Element because of the presence of recent alluvial deposits and groundwater less than 30 feet below ground surface (City of Los Angeles 1996a). Similarly, Port of Long Beach Berths 76-78 and 84-87 are located in an area of generally loose, compressible hydraulic fill, with groundwater located at a depth of 10 to 12 feet; therefore, the soils are potentially liquefiable (Dames & Moore 1993). Other authors (e.g., Pyke 1990) indicate that the overall probability of widespread liquefaction of uncompacted hydraulic fills and major damage in the Port is judged to be relatively low. However, even minor damage resulting from liquefaction can be very significant in terms of loss of functionality and repair costs (Pyke 1990).

Pier 400 is a rock-dike-retained hydraulic landfill island that was constructed in two stages from 1994 to 2000 using the latest geotechnical engineering data available, including an estimation of the liquefaction potential (Fugro West 2004). Although liquefaction on Pier 400 as a result of severe seismically induced ground motion cannot be precluded, such recent engineering will substantially reduce the likelihood for ground failure due to liquefaction. However, some of the proposed pipeline alignments and Tank Farm Site 2 are located in areas of older hydraulic fills, some of which were constructed with undocumented fill materials, which are generally unconsolidated, soft, and partially saturated, which creates a potential for liquefaction.

Tsunamis

Tsunamis are gravity waves of long wavelength generated by a sudden disturbance in a body of water. Typically, oceanic tsunamis are the result of sudden vertical movement along a fault rupture in the ocean floor, submarine landslides or subsidence, or volcanic eruption, where the sudden displacement of water sets off transoceanic waves with wavelengths of up to 125 miles (200 kilometers [km]) and with periods generally from 5 to 60 minutes. The trough of the tsunami wave arrives first leading to the classic retreat of water from the shore as the ocean level drops. This is followed by the arrival of the crest of the wave which can run up on the shore in the form of bores or surges in shallow water or simple rising and lowering of the water level in relatively deeper water such as in harbor areas.

Tsunamis are a relatively common natural hazard, although most of the events are small in amplitude and not particularly damaging. However, in the event of a large submarine earthquake or landslide, coastal flooding may be caused by either run-up of broken tsunamis in the form of bores and surges or by relatively dynamic flood waves. In the process of bore/surge-type run-up, the onshore flow (up to tens of ft per second) can cause tremendous dynamic loads on the structures onshore in the form of impact forces and drag forces, in addition to hydrostatic loading. The subsequent drawdown of the water after run-up exerts the often crippling opposite drags on the structures and washes loose/broken properties and debris to sea; the floating debris brought back on the next onshore flow have been found to be a significant cause of extensive damage after successive run-up and drawdown.

Abrupt sea level changes associated with tsunamis in the past have reportedly caused damage to moored vessels within the outer portions of the Los Angeles Harbor. The Chilean Earthquake of May 1960, for example, caused local damages of over $1 million and Harbor closure. One person drowned at Cabrillo Beach and one was injured. Small craft moorings in the Harbor area, especially in the Cerritos Channel, where a seiche occurred, were seriously damaged. Hundreds of small boats broke loose from their moorings, 40 sank, and about 200 were damaged. Gasoline from damaged boats caused a major spill in the Harbor waters and created a fire hazard. Currents of up to 8 knots and a 6-ft (1.8-m) rise of water in a few minutes were observed in the West Basin. The maximum water level fluctuations recorded by gauges were 5.0 ft (1.5 m) at LAHD Berth 60 (near Pilot Station) and 5.8 ft (1.8 m) in Long Beach Harbor (National Geophysical Data Center 1993).

Until recently, projected tsunami run-ups along the western U.S. were based on farfield events, such as submarine earthquakes or landslides occurring at great distances from the U.S., as described above for the Chilean Earthquake of May 1960. Based on such distant sources, tsunami-generated wave heights of between 6.5 ft (2 m) and 8 ft (2.4m) above lowest tide levels at 100-year intervals and between 10 ft (3 m) and 11 ft (3.4 m) at 500-year intervals, were projected, including the effects of astronomical tides (Houston 1980). These estimates were used for the tsunami analysis contained in the Deep Draft FEIS/FEIR in September 1992 (USACE and LAHD 1992).

However, more recent studies (e.g., Synolakis et al. 1997; Borrero, et al. 2001) have projected larger tsunami run-ups based on near-field events, such as earthquakes or submarine landslides occurring in proximity to the California coastline. Offshore faults present a larger local tsunami hazard than previously thought, posing a direct threat to nearshore facilities. For example, one of the largest such features, the Santa Catalina Fault, lies directly underneath Santa Catalina Island, located only 22 miles (35 km) from the Port. Simulations of tsunamis generated by uplift on this fault suggest waves in the Port in excess of 12 ft (3.7 m), with an arrival time within 20 minutes (Legg, et al. 2003; Borrero et al. 2005a). These simulations were based on rare events, representing somewhat of worst-case scenarios.

In addition, landslide derived tsunamis are now perceived as a viable local tsunami hazard. Such tsunamis can potentially be more dangerous, due to the lack of warning for such an event. This mechanism is illustrated by an earthquake in 1998, centered onshore Papua-New Guinea, which appears to have created an offshore landslide that caused tsunami inundation heights in excess of 33 ft (10 m), claiming more than 2,500 lives.

In a study modeling potential tsunami generation by local offshore earthquakes, Legg, et al. (2004), consider the relative risk of tsunamis from a large catastrophic submarine landslide (likely generated by a seismic event) in offshore southern California versus fault-generated tsunamis. The occurrence of a large submarine landslide appears quite rare by comparison with the tectonic faulting events. Although many submarine landslides have been mapped off of the southern California shore, few appear to be of the scale necessary to generate a catastrophic tsunami. Of two large landslides that appear to be of this magnitude, Legg et al. indicate that one landslide is over 100,000 years old and the other landslide approximately 7,500 years old. In contrast, the recurrence of 3 to 20 ft (1 to 6 m) fault movements on offshore faults would be several hundred to several thousand years. Consequently, the study concludes that the most likely direct cause of most of the local tsunamis in southern California is tectonic movement during large offshore earthquakes.

Based on these recent studies (e.g., Synolakis et al. 1997; Borrero, et al. 2001), the California State Lands Commission (CSLC) has developed tsunami run-up projections for the Ports of Los Angeles and Long Beach of 8.0 ft (2.4 m) and 15.0 ft (4.6 m) above mean sea level, at 100- and 500-year intervals, respectively, as a part of Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS) (CSLC 2004a). However, these projections do not incorporate consideration of the localized landfill configurations, bathymetric features, and the interaction of the diffraction, reflection, and refraction of the tsunami wave propagation within the Los Angeles/Long Beach Port Complex in its predictions of tsunami wave heights.

Most recently, a model has been developed for the Los Angeles/Long Beach Port Complex that incorporates these additional factors (Moffatt & Nichol 2007). The following text summarized this recent model. Additionally, a copy of the detailed model report is provided in Appendix M. The Port Complex model uses a methodology similar to the above studies to generate a tsunami wave from several different potential sources, including local earthquakes, remote earthquakes, and local submarine landslides. This model indicates that a reasonable maximum source for future tsunami events at the proposed Project site would be a submarine landslide along the nearby Palos Verdes Peninsula.

The Port Complex model predicts tsunami wave heights locally in excess of 23 ft (7.0 m) at the western and southern faces of the Pier 400 Project site; up to 3.3 ft (1.0 m) at the northern end of Seaplane Anchorage, near Tank Farm Site 2; and up to 8.2 ft (2.5 m) at Berths 238-240.

With respect to the Port of Long Beach, the Port Complex model indicates that a reasonable maximum source for future tsunami events would be a magnitude 7.6 earthquake on the Santa Catalina Fault. The Port Complex model does not extend northward to Berths 76-78 and 84-87, within the Cerritos Channel; however, this model predicts maximum tsunami wave heights up to 2.6 to 3.3 ft (0.8 to 1.0 m) in the northern portion of the Back Channel, located immediately south of the Cerritos Channel.

Seiches

Seiches are seismically induced water waves that surge back and forth in an enclosed basin and may be expected in the harbor as a result of earthquakes. Any significant wave front could cause damage to seawalls and docks, and could breach sea walls at the proposed Project sites. Modern shoreline protection techniques are designed to resist seiche damage. The Los Angeles/Long Beach Port Complex model referred to above considered impacts from tsunamis and seiches. In each case, impacts from a tsunami were equal to or more severe than those from a seiche. As a result, the impact discussion below refers primarily to tsunamis as this will be considered the worst case of potential impacts.

Subsidence/Settlement

Subsidence or settlement is the phenomenon where the soils and other earth materials underlying the site settle or compress, resulting in a lower ground surface elevation. Fill and native materials on site can be water saturated and a net decrease in the pore pressure and contained water will allow the soil grains to pack closer together. This closer grain packing results in less volume and the lowering of the ground surface.

Subsidence in the Los Angeles-Long Beach Harbor area was first observed in 1928. It has affected the majority of the Harbor area. Based on extensive studies by the City of Long Beach and the California Division of Oil and Gas and Geothermal Resources, it has been determined that most of the subsidence was the result of oil and gas production from the Wilmington Oil Field following its discovery in 1936. However, groundwater withdrawal and tectonic movement also appears to have contributed to subsidence in the area, especially prior to discovery of oil in 1936.

The general harbor area, including the area of the tank farm sites, experienced maximum cumulative subsidence of approximately 1.6 ft (0.5 m), from 1928 to 1970 (Allen 1973). Today, water injection continues to be maintained at rates greater than the total volume of produced substances, including oil, gas, and water, to prevent further reservoir compaction and subsidence (City of Long Beach 2006).

Non-uniform compaction of soils can similarly result in localized areas of lowering of the ground surface. This phenomenon is also called differential settlement. Overlying structures can be damaged as a result of differential settlement.

Horizontal directional drilling (HDD) is commonly used to install pipelines underground. HDD can cause caving of sediments in the vicinity of the borehole, which in turn, can cause settling of overlying surfaces. HDD completed for Port projects has occasionally caused settlement of overlying soils within 150 feet of the borehole entry point.

Landslides

Generally, a landslide is defined as the downward and outward movement of loosened rock or earth down a hillside or slope. Landslides can occur either very suddenly or slowly and frequently accompany other natural hazards such as earthquakes, floods, or wildfires. Most landslides are single events, but more than a third are associated with heavy rains or the melting of winter snows. Additionally, landslides can be triggered by ocean wave action or induced by the undercutting of slopes during construction, improper artificial compaction, or saturation from sprinkler systems or broken water pipes. In areas on hillsides where the ground cover has been destroyed, landslides are probable because there is nothing to hold the soil. Immediate dangers from landslides are the destruction of property and possible fatalities from rocks, mud, and water sliding downhill or downstream. Other dangers include broken electrical, water, gas, and sewage lines. The proposed Project sites are relatively flat and no known or probable landslide areas have been identified (City of Los Angeles 1996a).

Expansive Soils

Expansive soils generally result from specific clay minerals that expand when saturated and shrink in volume when dry. Pier 400 was constructed primarily with sandy material (Fugro West, Inc. 2004); thus reducing the potential for expansive soils in that portion of the proposed Project area. However, expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula. Artificial fill soils along portions of the pipeline routes and at Tank Farm Site 2 could similarly be expansive.

Mineral Resources

The Surface Mining and Reclamation Act of 1975 (SMARA) was enacted to promote conservation of the State's mineral resources and to ensure adequate reclamation of lands once they have been mined. SMARA requires the State Geologist to classify land in California for mineral resource potential. The four categories include: Mineral Resource Zone (MRZ)-1, areas of no mineral resource significance; MRZ-2, areas of identified mineral resource significance; MRZ-3, areas of undetermined mineral resource significance; and MRZ-4, areas of unknown mineral resource significance.

The northern portion of the proposed Project area, between the Ultramar Liquid Bulk Terminal and the Ultramar/Valero Refinery, as well as portions of the Port of Long Beach, are located within the Wilmington Oil Field, a broad, asymmetric anticline broken by a series of transverse normal faults that have created seven major oil-producing zones, from which production began in 1936 (Mayuga 1970). The field is approximately 11 miles (17.6 km) long and 3 miles (4.8 km) wide, covering approximately 13,500 acres (5,466 ha). The Wilmington Oil Field produced 84.4 million barrels (bbl) of oil from January 1998 through October 2002, making it the 6th largest producing oil field in the state (California Department of Conservation 2002).

According to the CDMG, the proposed Project Marine Terminal, Tank Farm Sites 1 and 2, LAHD Berths 238-240, and Port of Long Beach Berths 76-78 and 84-87 are located in a Mineral Resource Zone (MRZ) area classified as "MRZ-1," which is defined as an area where adequate information indicates that no significant mineral deposits (i.e., aggregate deposits) are present or where it is judged that little likelihood exists for their presence (CDMG 1994).

3.5.3 Applicable Regulations

Geologic Hazards

Geologic resources and geotechnical hazards in the proposed Project vicinity are governed primarily by the City of Los Angeles. The conservation and safety elements of the City of Los Angeles General Plan contain policies for the protection of geologic features and avoidance of geologic hazards (City of Los Angeles 1996a and 2001a). Local grading ordinances establish detailed procedures for excavation and earthwork required during construction in backland areas. In addition, City of Los Angeles building codes and building design standards for the Port establish requirements for construction of aboveground structures (City of Los Angeles 2002e). Most local jurisdictions rely on the 1997 California Uniform Building Code (UBC) as a basis of seismic design. However, with respect to wharf construction, the LAHD standards and specifications would be applied to the design of the proposed Project. The LAHD must also comply with regulations of the Alquist-Priolo Act, which regulates development near active faults to mitigate the hazard of a surface fault rupture.

The MOTEMS were approved by the California Building Standards Commission on January 19, 2005 and are codified as part of California Code of Regulations, Title 24, Part 2, Marine Oil Terminals, Chapter 31F. These standards apply to all existing marine oil terminals in California and include criterion for inspection, structural analysis and design, mooring and berthing, geotechnical considerations, fire, piping, and mechanical and electrical systems. MOTEMS became effective on January 6, 2006 (CSLC 2006). The process of developing the MOTEMS has produced parallel guidelines and recommended provisions. The *Seismic Design Guidelines for Port Structures*, published in 2001 by the Port International Navigation Association (PIANC) uses text virtually identical to that found in the MOTEMS. The language for the PIANC and the MOTEMS is derived from the Naval Facilities Engineering Service Center Technical Report (TR-2103-SHR), *Seismic Criteria for California Marine Oil Terminals* (CSLC 2004a).

All Port pipelines are designed in accordance with the American Society of Mechanical Engineers/American National Standards Institute B31.4, "*Liquid Transportation Systems for Hydrocarbons, Liquid, Petroleum Gas, Anhydrous Ammonia, and Alcohols*". The design, construction, operation, and maintenance of all pipelines would be regulated by the U.S. Department of Transportation (DOT), under Title 49 of the CFR, Chapter I, DOT, Part 195. The integrity of marine oil pipelines is maintained through a preventative maintenance program, in accordance with American Petroleum Institute (API) Standards Applicable to Section 2570, Title 2, Division 3, Chapter 1, Article 5.5, of the California Code of Regulations (CSLC 2004b).

Mineral Resources

Excavations and pipeline construction in the immediate vicinity of existing oil facilities is regulated in accordance with standards and procedures as set forth by the California Department of Conservation Division of Oil, Gas, and Geothermal Resources (DOGGR). If any structure is to be located over or in proximity to a previously abandoned well, the well may require re-abandonment. Public Resources Code, Section 3208.1, authorizes the State Oil and Gas Supervisor to order re-abandonment of any previously abandoned well when construction of any structure over or in proximity to the well could result in a hazard.

SMARA was enacted to promote conservation of the State's mineral resources and to ensure adequate reclamation of lands once they have been mined. Among other provisions, SMARA requires the State Geologist to classify land in California for mineral resource potential. The four categories include: Mineral Resource Zone (MRZ)-1, areas of no mineral resource significance; MRZ-2, areas of identified mineral resource significance; MRZ-3, areas of undetermined mineral resource significance; and MRZ-4, areas of unknown mineral resource significance.

The distinction between these categories is important for land use considerations. The presence of known mineral resources, which are of regional significance and possibly unique to that particular area, could potentially result in non-approval or changes to a given project if it were determined that those mineral resources would no longer be available for extraction and consumptive use. To be considered significant for the purpose of mineral land classification, a mineral deposit, or a group of mineral deposits that can be mined as a unit, must meet marketability and threshold value criteria adopted by the California State Mining and Geology Board. The criteria vary for different minerals depending on the following: (1) whether the minerals are strategic or non-strategic, (2) the uniqueness or rarity of the minerals, and (3) the commodity-type category (metallic minerals, industrial minerals, or construction materials) of the minerals. The State Geologist submits the mineral land classification report to the State Mining and Geology Board, which transmits the information to appropriate local governments that maintain jurisdictional authority in mining, reclamation, and related land use activities. Local governments are required to incorporate the report and maps into their general plans and consider the information when making land use decisions.

3.5.4 Impacts and Mitigation Measures

3.5.4.1 Methodology

Geological impacts were evaluated in two ways: (1) impacts of the proposed Project on the local geologic environment; and (2) impacts of geohazards on proposed Project components that may result in substantial damage to structures or infrastructure or expose people to substantial risk of injury. Impacts would be considered significant if the proposed Project meets any of the significance criteria identified below.

3.5.4.1.1 CEQA Baseline

Section 15125 of the California Environmental Quality Act (CEQA) Guidelines requires EIRs to include a description of the physical environmental conditions in the vicinity of a project that exist at the time of the NOP. These environmental conditions would normally constitute the baseline physical conditions by which the CEQA lead agency determines whether an impact is significant. For purposes of this Draft Supplemental Environmental Impact Statement/Subsequent Environmental Impact Report (SEIS/SEIR), the CEQA Baseline for determining the significance of potential impacts under CEQA is June 2004. CEQA Baseline conditions are described in Section 2.6.2.

The CEQA Baseline represents the setting at a fixed point in time, with no project growth over time, and differs from the “No Federal Action/No Project” Alternative (discussed in Section 2.5.2.1) in that the No Federal Action/No Project Alternative addresses what is likely to happen at the site over time, starting from the baseline conditions. The No Federal Action/No Project Alternative allows for growth at the proposed Project site that would occur without any required additional approvals.

3.5.4.1.2 NEPA Baseline

For purposes of this Draft SEIS/SEIR, the evaluation of significance under the National Environmental Policy Act (NEPA) is defined by comparing the proposed Project or other alternative to the No Federal Action scenario (i.e., the NEPA Baseline and No Federal Action Alternative are equivalent for this project). Unlike the CEQA Baseline, which is defined by conditions at a point in time, the NEPA Baseline/No Federal Action is not bound by statute to a “flat” or “no growth” scenario; therefore, the USACE may project increases in operations over the life of a project to properly analyze the NEPA Baseline/No Federal Action condition.

The NEPA Baseline condition for determining significance of impacts is defined by examining the full range of construction and operational activities that are likely to occur without a permit from the USACE. As documented in Section 2.6.1, the USACE, the LAHD, and the applicant have concluded that no part of the proposed Project would be built absent a USACE permit. Thus, for the case of this project, the NEPA Baseline is identical to the No Federal Action/No Project Alternative (see Section 2.6.1). Elements of the NEPA Baseline include:

- Paving, lighting, fencing, and construction of an access road at Tank Farm Site 1 to allow intermittent temporary storage of chassis-mounted containers on the site by APM;
- Paving, fencing, and lighting at Tank Farm Site 2 to allow intermittent temporary wheeled container storage by APL or Evergreen; and
- Additional crude oil deliveries at existing crude oil terminals in the San Pedro Bay Ports.

Significance of the proposed Project or alternative is defined by comparing the proposed Project or alternative to the NEPA Baseline (i.e., the increment). The NEPA Baseline conditions are described in Section 2.6.1 and 2.5.2.1.

3.5.4.2 Thresholds of Significance

The following criteria are based on the *L.A. CEQA Thresholds Guide* (City of Los Angeles 2006) and are the basis for determining the significance of impacts associated with geology resulting from proposed Project development.

A project would have a significant geologic hazard impact if it would cause or accelerate hazards that would result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury. Impacts are based on the probable severity of consequences to people, property, or infrastructure, as well as the probable frequency of potential geologic hazards. Because the region is generally considered to be geologically active, most projects are exposed to some risk from geologic hazards, such as earthquakes. Geologic impacts would therefore be considered significant only if the proposed Project would result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from:

GEO-1: Fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure;

GEO-2: Tsunamis or seiches;

GEO-3: Land subsidence/settlement;

GEO-4: Expansive soils;

GEO-5: Landslides, mudflows; or

GEO-6: Unstable soil conditions from excavation, grading, or fill.

In addition:

GEO-7: A project would normally have a significant impact on landform alteration if one or more distinct and prominent geologic or topographic features would be destroyed, permanently covered, or materially and adversely modified. Such features may include, but not be limited to, hilltops, ridges, hill slopes, canyons, ravines, rock outcrops, water bodies, streambeds, and wetlands.

GEO-8: A project would normally have a significant impact on mineral resources if it resulted in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the state.

See Section 3.7, Groundwater and Soils for significance criteria related to erosion.

3.5.4.3 Project Impacts and Mitigation

The assessment of impacts is based on regulatory controls and on the assumptions that the proposed Project would include the following:

- The Port will design and construct onshore improvements in accordance with Los Angeles Building Code, Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, to minimize impacts associated with seismically induced geohazards. Sections 91.000 through 91.7016 of the Los Angeles Municipal Code regulate construction in onshore areas of the Port. These building codes and criteria provide requirements for construction, grading, excavations, use of fill, and foundation work, including type of materials, design, procedures, etc. These codes are intended to limit the probability of occurrence and the severity of consequences from geological hazards. Necessary permits, plan checks, and inspections are also specified. The Los Angeles Municipal Code also incorporates structural seismic requirements of the California Uniform Building Code, which classifies almost all of coastal California (including the Project site) within Seismic Zone 4, on a scale of 1 to 4, with 4 being most severe. The Project engineers shall review the Project plans for compliance with the appropriate standards in the building codes.

- The Port will design and construct wharf improvements in accordance with MOTEMS and the LAHD standards, to minimize impacts associated with seismically induced geohazards. Such construction shall include, but not be limited to, completion of site-specific geotechnical investigations regarding construction and foundation engineering. Measures pertaining to temporary construction conditions, such as maximum temporary slope gradient, will be incorporated into the design. A licensed geologist or engineer will monitor construction to verify that construction occurs in concurrence with proposed Project design.

For consistency with the Deep Draft FEIS/FEIR, **MM 4A-4** and **MM 4A-6**, which require site-specific geotechnical investigations to reduce geohazard impacts, would apply to the proposed Project and would be implemented as discussed below for **Impact GEO-1** and **Impact GEO-3**.

3.5.4.3.1 Proposed Project

Impact GEO-1: The proposed Project would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.

Seismicity and Faulting

The proposed Project sites are susceptible to seismically induced ground shaking and related hazards, including surface rupture and liquefaction. Such hazards could occur due to movement on the Palos Verdes Fault Zone, which traverses the proposed Project area, and on other regional faults. Recently identified strands of the active Palos Verdes Fault (McNeilan et al. 1996) traverse the central portion of Pier 400, approximately 0.5 mile (0.8 km) northeast of the proposed Marine Terminal. Based on this and other interpretations of the location of the fault (see Figure 3.5-2), neither the Marine Terminal site nor Tank Farm Sites 1 or 2 are underlain by strands of the fault. However, the existing and proposed pipeline routes traverse two mapped strands of the Palos Verdes Fault. Although the exact locations of these two fault strands are not well constrained, such portions of the pipeline route would be subject to potential surface fault rupture in the event of a large earthquake on this fault.

The level of ground shaking is controlled by characteristics of the local geology. Two important characteristics are ground softness at a site and the total thickness of sediments beneath a site. Seismic waves travel faster through hard rocks than through softer rocks and sediments. As the waves pass from harder to softer rocks and slow down, they become bigger in amplitude to carry the same amount of energy. Thus, shaking tends to be stronger at sites with softer surface layers, such as those found at the proposed Project sites, where seismic waves move more slowly.

Ground shaking potential can be expressed qualitatively using the Modified Mercalli Scale or quantitatively by the peak horizontal ground acceleration (PHGA), which is calculated based upon the MCE, or the seismic event considered likely to occur on an active fault. Estimated PHGA generated on the faults listed in Table 3-5.1 should range from about 0.5 g to 0.42 g (Blake 2000). In addition, recent studies indicate that the MCE for the Palos Verdes Fault is Richter magnitude 7.25, with a recurrence interval of 900 years and peak ground accelerations in the Port area of 0.28 g and

0.52 g, for the OLE and CLE, respectively. These earthquakes would generate enough energy and spectral content and have a sufficiently long duration to damage structures in the area.

Proposed Project Construction and Operational Integrity

With respect to construction of the proposed Project, the proposed Marine Terminal, pipelines, and tank farm facilities would be designed per the MOTEMS to protect against potential seismic hazards that could occur. As discussed in Section 3.5.3, the MOTEMS were approved by the California Building Standards Commission on January 19, 2005 and are codified as part of California Code of Regulations, Title 24, Part 2, Marine Oil Terminals, Chapter 31F. These standards apply to all existing marine oil terminals in California and include criterion for inspection, structural analysis and design, mooring and berthing, geotechnical considerations, fire, piping, and mechanical and electrical systems. MOTEMS became effective on January 6, 2006 (CSLC 2006).

In accordance with MOTEMS, annual walk-down inspections must be completed at all marine terminals. In addition, MOTEMS related audits must be completed every three years for above water structures; every one to six years for underwater structures (based on the results of the annual inspection); and following significant events, such as earthquakes, flooding, fire, or vessel impact. Structural upgrades would subsequently occur, as necessary, based on the results of the audits.

The process of developing the MOTEMS has produced parallel guidelines and recommended provisions. The *Seismic Design Guidelines for Port Structures*, published in 2001 by the Port International Navigation Association (PIANC) uses text virtually identical to that found in the MOTEMS. The language for the PIANC and the MOTEMS is derived from the Naval Facilities Engineering Service Center Technical Report (TR-2103-SHR), *Seismic Criteria for California Marine Oil Terminals* (CSLC 2004a).

The LAHD Code for Seismic Design, Upgrade and Repair of Container Wharves (5/18/2004) would supersede MOTEMS, in case of conflict, only if proven to be more severe or restrictive. This is to ensure a conservative design approach compatible with both codes.

In addition to MOTEMS and the Port's code, the new facilities, including three buildings proposed for construction at the Marine Terminal (i.e., the Terminal Control, Administration, and Security buildings) and at least one building at each tank farm (i.e., motor control center and an office/control center) would be designed in accordance with all other appropriate recognized engineering, safety, and seismic hazard design standards. The most severe or restrictive design code in effect at the time would apply. Details of the facilities design, including general specifications, standards, and dimensions, are included in Appendix E and summarized below.

As part of the lease agreement, accelerometers would be installed on the deck of the unloading platform to measure structure response and displacement during earthquake events. This would aid the operator in determining if the structure exceeded design structural criteria and what level of pre-established inspection program should be implemented.

Pipeline Segment 1 would be comprised of a 0.375-inch wall thickness pipe over most of the length, but 0.75-inch wall thickness in the vicinity of the Palos Verdes Hill Fault to accommodate seismic stresses. All pipelines would be designed in accordance with the American Society of Mechanical Engineers/American National Standards Institute B31.4, "*Liquid Transportation Systems for Hydrocarbons, Liquid, Petroleum Gas, Anhydrous Ammonia, and Alcohols*". The design, construction, operation, and maintenance of all pipelines would be regulated by the U.S. Department of Transportation (DOT), under Title 49 of the CFR, Chapter I, DOT, Part 195. The integrity of marine oil pipelines would also be maintained through a preventative maintenance program, in accordance with American Petroleum Institute (API) Standards Applicable to Section 2570, Title 2, Division 3, Chapter 1, Article 5.5, of the California Code of Regulations (CSLC 2004b). System inspection of the pipelines would include hydrostatic testing to check for pipeline leakage, as required by the DOT. The pipeline routes would be visually inspected at least biweekly by line rider patrol, in accordance with DOT requirements (49 CFR, Part 195) to spot factors that might threaten the integrity of the pipelines.

All tanks would be designed in accordance with the API Standard for Welded Steel Tanks for Oil Storage, API-650, and would be welded with primary and secondary seals. Each tank would be equipped with secondary leak detection systems, overfill protection, and instrumentation to monitor temperature and monitor/control tank level in order to prevent releases. The secondary leak detection system would generally consist of a primary welded and coated steel bottom that would rest on a bed of sand, or other similar material, under which would be installed an impermeable foundation or liner. This system would be designed to monitor for leaks in the steel bottom. Each tank would be designed to allow for monitoring and control from the Marine Terminal Control Building. Dike walls around the tank areas would provide for full containment of the largest tank volume, in the event of a spill or tank breech.

In addition, LAHD standards and specifications would be applied to the seismic design of the proposed Project. Design objectives for both wharf and backland areas are for the proposed Project to maintain operation following an OLE and to survive without collapse and provide public safety following a CLE. At the lower-level OLE, structures are expected to suffer minor, nonstructural damage and resume operations immediately after the earthquake. At the higher-level CLE, structural damage is permissible as long as public safety is not jeopardized.

CEQA Impact Determination

Because of the proximity of the active Palos Verdes Fault, construction of the Marine Terminal and associated tanks and pipelines would expose people and property to a greater than average risk of fault rupture, seismic ground shaking, liquefaction, and other seismically induced ground failure. Earthquake-resistant standards were incorporated into the design of recently completed Pier 400 to reduce potential impacts from a major earthquake. Similarly, the proposed Marine Terminal and related infrastructure would be constructed in accordance with modern earthquake-resistant standards to reduce potential impacts from a major earthquake. However, as discovered during the 1971 San Fernando earthquake and the 1994 Northridge earthquake, existing building codes are sometimes inadequate to completely protect engineered structures from seismic impacts and other seismically induced hazards.

As a result, exposure of people and property to substantial risk of injury from an earthquake during proposed Project operations cannot be precluded, even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismicity would be significant and unavoidable.

Mitigation Measures

MM 4A-4: Seismic Design. A site-specific geotechnical investigation shall be completed by a California-licensed geotechnical engineer and/or engineering geologist. The results shall be incorporated into the structural design of Project components.

Residual Impacts

Design and construction in accordance with recommendations of a site-specific geotechnical investigation, as well as applicable laws and regulations pertaining to seismically induced ground movement, would minimize structural damage in the event of an earthquake. However, increased exposure of people and property during operations to seismic hazards from a major or great earthquake cannot be precluded even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismically induced ground failure would remain significant with mitigation.

NEPA Impact Determination

Because of the proximity of the active Palos Verdes Fault, construction of the Marine Terminal and associated tanks and pipelines would expose people and property to a greater than average risk of fault rupture, seismic ground shaking, liquefaction, and other seismically induced ground failure. Earthquake-resistant standards were incorporated into the design of recently completed Pier 400 to reduce potential impacts from a major earthquake. Similarly, the proposed Marine Terminal and related infrastructure would be constructed in accordance with modern earthquake-resistant standards to reduce potential impacts from a major earthquake. However, as discovered during the 1971 San Fernando earthquake and the 1994 Northridge earthquake, existing building codes are sometimes inadequate to completely protect engineered structures from seismic impacts and other seismically induced hazards. As a result, exposure of people and property to substantial risk of injury from an earthquake during proposed Project operations cannot be precluded, even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismicity would be significant and unavoidable under NEPA.

Mitigation Measures

MM 4A-4, which requires completion of a site-specific geotechnical investigation, shall be applied to reduce potentially significant seismic impacts to property and on-site personnel.

Residual Impacts

Design and construction of existing facilities in accordance with recommendations of a site-specific geotechnical investigation, as well as applicable laws and regulations pertaining to seismically induced ground movement, would minimize structural damage in the event of an earthquake. However, exposure of people and property during operations to seismic hazards from a major or great earthquake cannot be precluded even with incorporation of modern construction engineering and safety standards. Therefore, impacts due to seismically induced ground failure would remain significant and unavoidable.

Impact GEO-2: The proposed Project could expose people or property to substantial risk of tsunamis or seiches.

Tsunami Runup

Due to the historic occurrence of earthquakes and tsunamis along the Pacific Rim, placement of any development on or near the shore in southern California, including the proposed Project sites, would always involve some measure of risk of impacts from a tsunami or seiche. Although relatively rare, should a large tsunami or seiche occur, it would be expected to cause some amount of damage and possibly injuries to most on- or near-shore locations. As a result, this is considered by the LAHD as the average, or normal condition for most on- and near-shore locations in southern California. Therefore, a proposed Project tsunami or seiche related impact would be one that would exceed this normal condition and cause substantial damage and/or substantial injuries. For reasons explained below, under certain scenarios, this proposed Project would likely expose people or property to substantial damage or substantial injuries in the event of a tsunami or seiche. Therefore, impacts would be significant.

Since tsunamis and seiches are derived from wave action, the risk of damage or injuries from these events at any particular location is lessened if the location is high enough above sea level, far enough inland, or protected by manmade structures such as dikes or concrete walls. The height of a given site above sea level is either the result of an artificial structure (e.g., a dock or wall), topography (e.g., a hill or slope), or both, and a key variable related to the height of a site location relative to sea level is the behavior of tides. During high tide, for instance, the distance between the site and sea level is less. During low tide, the distance is greater. How high a site must be located above sea level to avoid substantial wave action during a tsunami or seiche depends upon the height of the tide at the time of the event and the height of the potential tsunami or seiche wave. These factors are considered for the proposed Project site, as described below.

The Port is subject to diurnal tides, meaning two high tides and two low tides during the 24-hour day. The average of the lowest water level during low tide periods each day is typically set as a benchmark of 0 ft (0 m) and is defined as Mean Lower Low Water level (MLLW). For purposes of this discussion, all proposed Project structures and land surfaces are expressed as height above (or below) MLLW. The mean sea level (MSL) in the Port is +2.8 ft (0.84-87 m) above MLLW (NOAA 2005). This height reflects the arithmetic mean of hourly heights observed over the

National Tidal Datum Epoch (19 years) and therefore reflects the mean of both high and low tides in the Port.

Generalized modeling completed by Borrero et al. (2005b) indicates that a large submarine landslide off the southern tip of the Palos Verdes Peninsula could result in 13 ft (4 m) of runup in the San Pedro Bay Ports. Such runup may inundate the proposed Project site and potentially cause up to $36 billion direct, indirect, and induced losses in the Port areas.

Most recently and more definitively, a model has been developed specifically for the Los Angeles/Long Beach Port Complex that incorporates consideration of the localized landfill configurations, bathymetric features, and the interaction of the diffraction, reflection, and refraction of tsunami wave propagation, in the predictions of tsunami wave heights (Moffatt and Nichol 2007, see Appendix M). This model predicts tsunami wave heights with respect to MSL, rather than MLLW, and therefore can be considered a reasonable average condition under which a tsunami might occur. However, the Port MSL of +2.82 ft (0.84-87 m) must be considered in comparing projected tsunami run-up (i.e., amount of wharf overtopping and flooding) to proposed wharf height and topographic elevations, which are measured with respect to MLLW.

Table 3.5-3 provides a summary of the analysis of potential tsunami impacts for the proposed Project. Based on the Port Complex model, several parameters have been analyzed for each proposed Project location, starting with the height of the site or any structure at the shoreline. Where a containment wall or dike is planned (or exists) for construction to protect against wave action, the height of this structure has been added (separately) to the site elevation to provide a complete demonstration of the ability of the site to withstand a tsunami or seiche wave. Further, the distance from the shoreline is also considered, to the extent that this distance could reduce overall wave impacts. These factors are evaluated relative to the height of a potential wave at each location, with the additive effects of mean sea level also included.

Table 3.5-3. Proposed Project Impacts at Shore and Backland Elevations

Maximum Likely Case									
Site	*Site Elevation above MLLW Plus Containment*	*Distance From Shore*	*Mean Sea Level (MSL) (Height above MLLW)*	*Potential Tsunami Wave Height* (Above MSL)*	*Tsunami Height plus MSL*	*Tsunami Ht. Plus MSL Minus Site Elevation (Construction)*	*Tsunami Ht Plus MSL Minus Site Elev. Minus Containment and/or Topography (Operations)*	*Possible Flooding of the Site? (Const/Ops)*	*Possible Flooding of the Storage Tanks? (Const/Ops)*
Marine Terminal	15 ft No dike	0	2.8 ft	23.0+ ft	25.8+ ft	10.8+ ft	10.8+ ft	Yes/Yes	NA (no tanks)
Tank Farm Site 1	16.5 ft plus 8-ft dike = 24.5 ft	100 ft	2.8 ft	23.0+ ft	25.8+ ft	9.3+ ft	1.3+ ft	Yes/Yes	Yes/Yes
Tank Farm Site 2	16-23 ft plus 7-ft dike = 23-30 ft	700 ft	2.8 ft	3.3 ft	6.1 ft	-9.9 ft to -16.9 ft	-16.9 ft to -23.9 ft	No/No (Intervening Topography)	No/No
Note: * Tsunami height based on most likely worst-case scenario, which is a landslide off the Palos Verdes Peninsula.									

As shown in Table 3.5-3, the results of the analysis indicate that due to distance from shoreline, intervening topography, and ultimate containment structures, potential tsunami waves would not be expected to flood Tank Farm Site 2 under any construction or operations scenarios. However, this table illustrates that tsunami-induced flooding would occur during construction and operations at the Marine Terminal and Tank Farm Site 1.

As previously discussed, this tsunami-induced run-up analysis is based on MSL, which is the mean of both high and low tides over a 19 year period and is thus a reasonable datum from which to complete the analysis. However, theoretical maximum worst-case wave action from a tsunami has also been considered. Such a wave action would result if the single highest tide predicted over the next 40 years at the San Pedro Bay Ports was present at the time of the seismic event. The single highest tide predicted over the next 40 years is 7.3 ft (2.2 m) above MLLW. This condition is expected to occur less than 1 percent of the time over this 40-year period. As summarized in Table 3.5-4, flooding would occur at the proposed Project sites under the same scenarios as under the maximum likely case, as summarized in Table 3.5-3. Potential tsunami waves would not be expected to flood Tank Farm Site 2 under any construction or operations scenarios. However, tsunami-induced flooding would occur during construction and operations at the Marine Terminal and Tank Farm Site 1.

Table 3.5-4. Proposed Project Impacts at Shore and Backland Elevations

Theoretical Maximum Worst Case									
Site	*Site Elevation above MLLW Plus Containment*	*Distance from Shore*	*Highest Anticipated Tide (Height above MLLW)*	*Potential Tsunami Wave Height* (Above MSL)*	*Tsunami Height plus Highest Tide*	*Tsunami Ht plus HWL Minus Site Elevation (Construction)*	*Tsunami Plus HWL Minus Site Elev. Minus Containment and/or Topography (Operations)*	*Possible Flooding of the Site? (Const/Ops)*	*Possible Flooding of the Storage Tanks? (Const/Ops)*
Marine Terminal	15 ft No dike	0	7.3 ft	23.0+ ft	30.3+ ft	+15.3 ft	+15.3 ft	Yes/Yes	NA
Tank Farm Site 1	16.5 ft plus 8-ft dike = 24.5 ft	100	7.3 ft	23.0+ ft	30.3+ ft	+13.8 ft	+5.8 ft	Yes/Yes	Yes/Yes
Tank Farm Site 2	16-23 ft plus 7-ft dike = 23-30 ft	700 ft	7.3 ft	3.3 ft	10.6 ft	-5.4 ft to -12.4 ft	-12.4 ft to -19.4 ft	No/No (Intervening Topography)	No/No

Note: * Tsunami height based on most likely worst-case scenario, which is a landslide off the Palos Verdes Peninsula.

To determine the extent of potential impacts due to tsunami-induced flooding, the LAHD structural engineers have determined that the Port reinforced concrete or steel structures designed to meet California earthquake protocols incorporated into MOTEMS would be expected to withstand complete inundation in the event of a tsunami (personal communication, P. Yin, 2006). As discussed in **Impact GEO-1**, the MOTEMS were approved by the California Building Standards Commission on January 19, 2005 and are codified as part of California Code of Regulations, Title 24, Part 2, Marine Oil Terminals, Chapter 31F. These standards apply to all existing marine oil terminals in California and include criterion for inspection, structural analysis and design, mooring and berthing, geotechnical considerations, fire, piping, and mechanical and electrical systems. MOTEMS became effective on January 6, 2006 (CSLC 2006).

The process of developing the MOTEMS has produced parallel guidelines and recommended provisions. The *Seismic Design Guidelines for Port Structures*, published in 2001 by the Port International Navigation Association (PIANC) uses text virtually identical to that found in the MOTEMS. The language for the PIANC and the MOTEMS is derived from the Naval Facilities Engineering Service Center Technical Report (TR-2103-SHR), *Seismic Criteria for California Marine Oil Terminals* (CSLC 2004a). However, substantial infrastructure damage and/or injury to personnel could occur as a result of complete site inundation.

Tsunami Probability

As previously discussed, there is a potential for tsunami-induced flooding, under the most likely worst-case scenario and theoretical maximum worst-case scenario, during construction and operations at the Marine Terminal and Tank Farm Site 1. However, the likelihood of a large tsunami is very low during the lifetime of the proposed Project.

The most likely worst-case tsunami scenario was based partially on a magnitude 7.6 earthquake on the offshore Santa Catalina Fault. The recurrence interval for a magnitude 7.5 earthquake along an offshore fault in the southern California Continental Borderland is about 10,000 years. Similarly, the recurrence interval of a magnitude 7.0 earthquake is about 5,000 years and the recurrence interval of a magnitude 6.0 earthquake is about 500 years. However, there is no certainty that any of these earthquake events would result in a tsunami, since only about 10 percent of earthquakes worldwide result in a tsunami. In addition, available evidence indicates that tsunamigenic landslides would be extremely infrequent and occur less often than large earthquakes. This suggests recurrence intervals for such landslide events would be longer than the 10,000-year recurrence interval estimated for a magnitude 7.5 earthquake (Moffatt & Nichol 2007).

Tanker Vessels

For tanker vessels, the risk of tsunami or seiches is a part of any ocean-shore interface and hence vessels in transit or at berth cannot avoid some risk of exposure. A tanker vessel destined for the proposed Project berths (or any berth in the Port) would be under its own power and have one or more tugs in attendance. Under this circumstance, the vessel would likely be able to maneuver to avoid damage as it would with any ocean wave. The exposure of a tsunami or seiche to a vessel in transit to or from the proposed Project berth, and the associated risk, is no different than for any other vessel entering the Port Complex.

The LAHD engineers have indicated that currents moving over 5 meters per second (m/s) could potentially render a ship out of control (personal communication, D. Hagner, 2006). Modeling indicates that tsunami related currents created as a result of a large earthquake on the Santa Catalina Fault or submarine landslide off the coast of the nearby Palos Verdes Peninsula would not create currents in the Port in excess of 5 m/s. Highest anticipated current speeds of 2 m/s would occur in the vicinity of Pier 400 and the entrance to the main channel (Moffatt and Nichol 2007).

A tanker vessel docked at the proposed Project berth would be subject to the rising and falling of the water levels and the accompanying currents during a tsunami or seiche. Two scenarios could arise. Either the vessel would stay secured to the berth and ride out the tsunami, or the motion during a tsunami would cause the vessel's mooring lines to break free and the vessel would be set adrift. In the first scenario, the energy of the tsunami wave would be transmitted through the vessel that is moored at berth and into the wharf. Forces transmitted through the vessel would be transferred to the wharf's fendering system and then to the wharf structure itself.

The existing wharf fendering systems are designed with the assumption that, under a normal docking scenario, a berthing vessel will contact only one fender. For such scenarios, each fender is designed to absorb the berthing energy of the entire vessel. During a tsunami occurrence, the wave is assumed to move the vessel against more than one of the existing fenders, so that the vessel would be contacting a minimum of four to five fenders, often simultaneously. In such cases, the forces experienced by each fender during a tsunami are often less (because more than one fender would absorb these forces at the same time) than the standard docking forces that the fendering system is designed for. Therefore, substantial damage is not expected to the vessel or the wharf in the event that a tsunami was to strike while a vessel was secured at a berth.

Under the second scenario, a vessel set adrift in the Port area could have more serious consequences from the potential of collision, including a potential hull breach and possible oil spill. This scenario is examined in Chapter 3.12, Risk of Upset/Hazardous Materials.

Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. However, in the event of such a tsunami, the operational procedures are to employ rapid shutdown in the operation of their terminal. In addition, MOTEMS require the operator to develop and employ procedures for emergency response to a seismic event, including tsunamis. Such procedures require the shutting down of unloading operations until an evaluation of the status of the terminal can be carried out.

CEQA Determination

Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by construction of the proposed Project. However, because the proposed Project elevation is located within 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches. Designing new facilities based on existing building codes may not prevent substantial damage to structures from coastal flooding. Projects in construction phases are especially susceptible to damage due to temporary conditions, such as unfinished structures, which are typically not in a condition to withstand coastal flooding.

In addition, even with implementation of proper MOTEMS protocol, a vessel set adrift in the Port area could have serious consequences from the potential of collision, including a potential hull breach and possible oil spill. Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. As a result, impacts would be significant and unavoidable under CEQA because the proposed Project could expose people or property to substantial risk of tsunamis or seiches.

Mitigation Measures

MM GEO-1: Emergency Response Planning. The Terminal operator shall work with Port engineers and Port police to develop tsunami response training and procedures to assure that construction and operations personnel will be prepared to act in the event of a large seismic event. Such procedures shall include immediate evacuation requirements in the event that a large seismic event is felt at the proposed Project site, as part of overall emergency response planning for this proposed Project.

Such procedures shall be included in any bid specifications for construction or operations personnel, with a copy of such bid specifications to be provided to the LAHD, including a completed copy of its operations emergency response plan prior to commencement of construction activities and/or operations.

Residual Impacts

Emergency planning and coordination between the Terminal operator and the LAHD, as outlined in **MM GEO-1**, would contribute in reducing injuries to on-site personnel during a tsunami. However, even with incorporation of emergency planning and construction in accordance with current City and State regulations, substantial damage and/or injury would occur in the event of a tsunami or seiche. Therefore, residual impacts would remain significant and unavoidable.

NEPA Impact Determination

Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by construction of the proposed Project. However, because the proposed Project elevation is located within 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches. Designing new facilities based on existing building codes may not prevent substantial damage to structures from coastal flooding. Projects in construction phases are especially susceptible to damage due to temporary conditions, such as unfinished structures, which are typically not in a condition to withstand coastal flooding.

In addition, even with implementation of proper MOTEMS protocol, a vessel set adrift in the Port area could have serious consequences from the potential of collision, including a potential hull breach and possible oil spill. Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. As a result, impacts would be significant and unavoidable under NEPA because the proposed Project could expose people or property to substantial risk of tsunamis or seiches.

Mitigation Measures

MM GEO-1 shall be applied to the NEPA project impact determination to reduce tsunami and seiche related impacts.

Residual Impacts

Emergency planning and coordination between the terminal operator(s) and the LAHD, as outlined in **MM GEO-1**, would contribute in reducing injuries to on-site personnel during a tsunami. However, even with incorporation of emergency planning and construction in accordance with current City and State regulations, substantial damage and injury would occur in the event of a tsunami or seiche. Therefore, residual impacts would remain significant and unavoidable.

Impact GEO-3: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.

Subsidence as a result of previous oil extraction in the Port area has been arrested as a result of water injection and is not anticipated to adversely impact the proposed Project. However, in the absence of proper engineering, HDD operations associated with pipeline construction and dewatering operations completed for excavations could induce settlement in underlying, unconsolidated sediments. Foundations of existing structures and proposed structures built on these sediments, such as the large crude oil tanks, could be cracked and warped by such settlement.

However, during design, the settlement potential of existing onshore soils would be evaluated through a site-specific geotechnical investigation, which includes subsurface soil sampling, laboratory analysis of samples collected to determine soil compressibility, and an evaluation of the laboratory testing results, by a geotechnical engineer. Recommendations of the engineer would be incorporated into the design specifications for the proposed Project, consistent with City design guidelines, including Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, in conjunction with criteria established by the LAHD and Caltrans. Recommendations for soils subject to settlement typically include overexcavation and recompaction of compressible soils, which would allow for construction of a conventional slab-on-grade; or alternatively, installation of concrete or steel foundation piles through the settlement prone soils, to a depth of competent soils. Such engineering has been proposed for the tank farms, where installation of stone columns (made from compacted gravel) has been proposed for support under the tanks. Such geotechnical engineering would substantially reduce the potential for soil settlement and would ensure that construction of the proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

CEQA Impact Determination

Subsidence in the vicinity of the proposed Project, due to previous oil extraction in the Port area, has been mitigated and is not anticipated to adversely impact the site. Impacts would be less than significant under CEQA because the proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.

Settlement impacts in onshore areas related to construction would be less than significant under CEQA, as the project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and Caltrans, and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

Because impacts would be less than significant, mitigation measures are not required. However, the following mitigation measure from the Deep Draft FEIS/FEIR would further reduce the potential for impacts:

MM 4A-6: Minimization of Settlement. A site-specific geotechnical investigation shall be completed by a California-licensed geotechnical engineer and/or engineering geologist. The results shall be incorporated into the structural design of Project components.

Residual Impacts

With implementation of a site-specific geotechnical investigation and Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, the residual impacts would be less than significant under CEQA.

NEPA Impact Determination

Subsidence in the vicinity of the proposed Project, due to previous oil extraction in the Port area, has been mitigated and is not anticipated to adversely impact the site. Impacts would be less than significant under NEPA because the proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.

Settlement impacts in onshore areas related to construction would be less than significant under NEPA, as the project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and Caltrans, and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

Because impacts would be less than significant, mitigation measures are not required. However, **MM 4A-6,** which requires completion of a site-specific geotechnical investigation, shall be applied to further reduce settlement impacts to property.

Residual Impacts

With implementation of a site-specific geotechnical investigation and Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, the residual impacts would be less than significant under NEPA.

Impact GEO-4: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from expansive soil.

Pier 400 was constructed primarily with sandy material, thus reducing the potential for expansive soils in that portion of the proposed Project area. However, expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula. Artificial fill soils along portions of the pipeline routes and at Tank Farm Site 2 could similarly be expansive. Use of expansive soils beneath proposed Project foundations in these areas could result in cracking and distress of foundations. Existing structures built on these sediments could be cracked and warped by such settlement.

However, the soil expansion potential would be evaluated through a site-specific geotechnical investigation, which includes subsurface soil sampling, laboratory analysis of samples collected to determine soil expansion potential, and an evaluation of the laboratory testing results, by a geotechnical engineer. Recommendations of the engineer would be incorporated into the design specifications for the proposed Project, consistent with City design guidelines, including Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, in conjunction with criteria established by the LAHD.

Recommendations for soils subject to expansion typically include overexcavation and replacement of expansive soils with sandy, non-expansive soils, which would allow for construction of a conventional slab-on-grade; construction of post-tensioning concrete slabs, which can accommodate movement of underlying expansive soils; or alternatively, installation of concrete or steel foundation piles through the expansion prone soils, to a depth of non-expansive soils. Such engineering has been proposed for the tank farms, where installation of stone columns (made from compacted gravel) has been proposed for support under the tanks. Such geotechnical engineering would substantially reduce the potential for soil expansion and damage to overlying structures.

CEQA Impact Determination

Expansive soil impacts in onshore areas would be less than significant under CEQA as the Project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

As expansive soil impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code resulting in no required mitigation, the residual impacts would be less than significant under CEQA.

NEPA Impact Determination

Expansive soil impacts in onshore areas would be less than significant under NEPA as the Project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

As expansive soil impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With implementation of standard geotechnical engineering and Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, less than significant residual impacts would occur under NEPA.

Impact GEO-5: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.

The topography of the proposed Project area is relatively flat; therefore, components of the proposed Project would not be subject to onshore landslides or mudflows. The Marine Terminal would be built overlying recently completed submarine slopes of Pier 400. These slopes were constructed in accordance with current City of Los Angeles building codes, which include provisions of the Uniform Building Code. These engineered slopes will be capable of supporting the proposed Marine Terminal.

CEQA Impact Determination

The topography in the vicinity of the proposed Project site is flat and not subject to landslides or mudflows. No impacts would occur under CEQA because the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from landslides or mudflows.

Mitigation Measures

As landslide and mudslide impacts would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under CEQA.

NEPA Impact Determination

No impacts would occur under NEPA because the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from landslides or mudflows.

Mitigation Measures

As landslide and mudslide impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under NEPA.

Impact GEO-6: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions from excavations, grading, or fill.

The proposed Project may include temporary excavations for construction of the Marine Terminal and associated infrastructure. In addition, trenching would be completed in association with pipeline installation. The flat nature of the topography and the minimal grading required for each land site would minimize the height and size of temporary slopes. In addition, the slopes would be constructed in accordance with provisions of the Occupational Health and Safety Administration (OSHA).

CEQA Impact Determination

The topography is generally flat and temporary slopes would be constructed in accordance with provisions of OSHA. Impacts would be less than significant under CEQA because the proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions from excavations, grading, or fill.

Mitigation Measures

No mitigation measures are necessary.

Residual Impacts

With no mitigation required, less than significant residual impacts would occur under CEQA.

NEPA Impact Determination

The topography is generally flat and temporary slopes would be constructed in accordance with provisions of OSHA. Impacts would be less than significant under

NEPA because the proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions from excavations, grading, or fill.

Mitigation Measures

As unstable soil conditions would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, less than significant residual impacts would occur under NEPA.

Impact GEO-7: The proposed Project would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

The proposed Project areas are relatively flat, with no distinct geologic or topographic features. In addition, the areas are underlain primarily by fill material, which was derived either from Port dredging activities or from imported fill.

CEQA Impact Determination

The topography is generally flat with no distinct geologic or topographic features. No impacts would occur under CEQA because the proposed Project would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

Mitigation Measures

No mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under CEQA.

NEPA Impact Determination

The topography is generally flat with no distinct geologic or topographic features. No impacts would occur under NEPA because the proposed Project would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

Mitigation Measures

As impacts due to removal of prominent geologic or topographic features would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under NEPA.

Impact GEO-8: The proposed Project would not result in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the state.

With respect to aggregate potential, the proposed Project site, including the tank farm sites, is located in MRZ-1, which is defined as an area where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence. However, with respect to petroleum resources, the northern portion of the proposed Project area is located within the Wilmington Oil Field. The northern section of proposed pipeline, between Berth 174 and the Ultramar/Valero Refinery, would preclude oil and gas drilling along the immediate pipeline right-of-way.

<u>CEQA Impact Determination</u>

Proposed Project construction would preclude oil and gas drilling from within proposed Project boundaries; however, petroleum reserves beneath the site could be accessed from remote locations, using directional (or slant) drilling techniques. Therefore, the proposed Project would not result in the permanent loss of availability of a known mineral resource that would be of future value to the region and the residents of the state. Mineral resource impacts would be less than significant under CEQA.

Mitigation Measures

As impacts associated with mineral resources would be less than significant, no mitigation measures are required.

Residual Impacts

With no mitigation required, the residual impacts are less than significant under CEQA.

<u>NEPA Impact Determination</u>

Proposed Project construction would preclude oil and gas drilling from within proposed Project boundaries; however, petroleum reserves beneath the site could be accessed from remote locations, using directional (or slant) drilling techniques. Therefore, the proposed Project would not result in the permanent loss of availability of a known mineral resource that would be of future value to the region and the residents of the state. Mineral resource impacts would be less than significant under NEPA.

Mitigation Measures

As impacts associated with mineral resources would be less than significant, no mitigation measures are required.

Residual Impacts

With no mitigation required, the residual impacts would be less than significant under NEPA.

3.5.4.3.2 No Federal Action/No Project Alternative

Under the No Federal Action/No Project Alternative, proposed Project facilities would not be constructed or operated. As described in Section 2.5.2.1, the No Federal Action/No Project Alternative considers the only remaining allowable and reasonably foreseeable use of the proposed Project site: Use of the site for temporary storage of wheeled containers on the site of Tank Farm 1 and on Tank Farm Site 2. This use would require paving, construction of access roads, and installation of lighting and perimeter fencing.

In addition, for analysis purposes, under the No Federal Action/No Project Alternative a portion of the increasing demand for crude oil imports is assumed to be accommodated at existing liquid bulk terminals in the San Pedro Bay Ports, to the extent of their remaining capacities. Although additional demand, in excess of the capacity of existing marine terminals to receive it, may come in by rail, barge, or other means, rather than speculate about the specific method by which more crude oil or refined products would enter southern California, for analysis purposes, the impact assessment for the No Federal Action/No Project Alternative in this SEIS/SEIR is based on marine deliveries only up to the available capacity of existing crude oil berths. As described in Section 2.5.2.1, the impact assessment for the No Federal Action/No Project Alternative also assumes existing terminals would eventually comply with the California State Lands Commission (CSLC) Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), that LAHD and the Port of Long Beach would renew the operating leases for existing marine terminals, and that existing terminals would comply with Clean Air Action Plan (CAAP) measures as of the time of lease renewal (i.e., 2008 for Port of Long Beach Berths 84-87, 2015 for LAHD Berths 238-240, and 2023 for Port of Long Beach Berths 76-78).

The NEPA Baseline condition coincides with the No Federal Action/No Project Alternative for this project because the USACE, the LAHD, and the applicant have concluded that, absent a USACE permit, no part of the proposed Project would be built (Section 2.6.1). All elements of the No Federal Action/No Project Alternative are identical to the elements of the NEPA Baseline. Therefore, under a NEPA determination there would be no impact associated with the No Federal Action/No Project Alternative.

Impact GEO-1: The No Federal Action/No Project Alternative would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.

In the absence of federal permits, no in-water construction would occur and no element of the proposed Project would be constructed. Construction would be limited to paving of Tank Farm Sites 1 and 2, for use as part of adjacent container terminals. Earthquake-related hazards at the Project site are the same under the No Federal

Action/No Project Alternative as those described above for the proposed Project. Although no construction related impacts would occur (damage to new pavement would not be considered significant), this alternative would continue to expose people to substantial risks associated with the geologic environment. Although less development and infrastructure would be susceptible to seismically induced ground failure under this alternative, impacts would potentially be greater than those described for the proposed Project, as aging marine terminals would potentially be operating out of compliance with MOTEMS for at least some of the period after 2010.

The proposed Project area lies in the vicinity of the Palos Verdes Fault Zone. Strands of the fault may pass beneath the pipeline route on Pier 400 (Figure 3.5-2). Strong-to-intense ground shaking, surface rupture, and liquefaction could occur in these areas, due to the location of the fault beneath the proposed Project area and the presence of water-saturated hydraulic fill. Similarly, LAHD Berths 238-240 is located less than 0.5 mile west of the fault zone and Port of Long Beach Berths 76-78 and 84-87 are located approximately 3 miles northeast of the fault zone (see Figures 3.5-1 and 3.5-2). With the exception of ground rupture, similar seismic impacts could occur at these berths due to earthquakes on the Palos Verdes Fault Zone or other regional faults. Earthquake-related hazards, such as liquefaction, ground rupture, ground acceleration, and ground shaking cannot be avoided in the Los Angeles and Long Beach regions and in particular in the harbor area where the Palos Verdes Fault is present and hydraulic and alluvial fill is pervasive.

Seismic hazards are common to the Los Angeles/Long Beach region and are not increased by the No Federal Action/No Project Alternative. However, as discovered during the 1971 San Fernando earthquake and the 1994 Northridge earthquake, existing building codes are often inadequate to completely protect engineered structures from hazards associated with liquefaction, ground rupture, and large ground accelerations. Consequently, existing facilities, including LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87, may be subject to significant damage from a major or great earthquake on the Palos Verdes Fault or any other regional fault.

In accordance with MOTEMS, annual walk-down inspections must be completed at all marine terminals. In addition, MOTEMS related audits must be completed every three years for above water structures; every one to six years for underwater structures (based on the results of the annual inspection); and following significant events, such as earthquakes, flooding, fire, or vessel impact. Structural upgrades would subsequently occur, as necessary, based on the results of the audits. However, there is no established time frame for completion of the upgrades. The schedule would be determined by the California State Lands Commission, in combination with the terminal operator. Therefore, in the absence of established structural upgrade scheduling, aging marine terminals, such as LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87, would potentially be operating out of compliance with MOTEMS for at least some of the period subsequent to 2010. By comparison, new facilities at Pier 400 would be in compliance with all applicable MOTEMS from initiation of proposed Project operations.

CEQA Impact Determination

Continued exposure of people and property during operations to seismic hazards from a major or great earthquake cannot be precluded, even with incorporation of modern construction engineering and safety standards (including MOTEMS). Therefore, impacts due to seismically induced ground failure are significant and unavoidable under CEQA.

Mitigation Measures

There are no mitigation measures available that would reduce impacts associated with seismically induced ground failure to less than significant levels.

Residual Impacts

Design and construction of existing structures, in accordance with applicable laws and regulations pertaining to seismically induced ground movement, including MOTEMS, would minimize structural damage in the event of an earthquake. However, increased exposure of people and property to seismic hazards from a major or great earthquake cannot be precluded even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismically induced ground failure would remain significant and unavoidable.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-2: The No Federal Action/No Project Alternative could expose people or property to substantial risk of tsunamis or seiches.

In the absence of federal permits, in-water construction would not occur and no development would occur within the proposed Project area. Construction would be limited to paving of Tank Farm Sites 1 and 2, for use as part of adjacent container terminals. Existing buildings and infrastructure may be subject to substantial damage from coastal flooding as a result of a large tsunami or seiche. Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by this alternative. However, because the proposed Project area elevation is within 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches (see Tables 3.5.3 and 3.5-4).

With respect to LAHD Berths 238-240, the Port Complex model predicts maximum tsunami wave heights up to 11.0 to 15.5 ft (3.3 to 4.6 m) above MLLW. However, because the berth height is approximately 14 feet above MLLW and there is a 23 foot wall surrounding the storage tanks, the site would not likely be inundated by a tsunami under maximum likely or theoretical maximum worst case scenarios (see Tables 3.5-5 and 3.5-6).

With respect to the Port of Long Beach, the Port Complex model indicates that a reasonable maximum source for future tsunami events would be a magnitude 7.6 earthquake on the Santa Catalina Fault. The Port Complex model does not extend northward to Berths 76-78 and 84-87, within the Cerritos Channel; however, this model predicts maximum tsunami wave heights up to 2.6 to 3.3 ft (0.8 to 1.0 m) in the northern portion of the Back Channel, located immediately south of the Cerritos Channel. Based on these relatively low runup values, it is unlikely that Berths 76-78 and 84-87 would be inundated as a result of reasonable worst-case tsunami scenario. However, higher current loads would be transferred from the vessel to the terminal structure during a tsunami or seiche.

Table 3.5-5: No Federal Action/No Project Alternative Impacts at Shore and Backland Elevations

Maximum Likely Case									
Site	*Site Elevation above MLLW Plus Containment*	*Distance From Shore*	*Mean Sea Level (MSL) (Height above MLLW)*	*Potential Tsunami Wave Height* (Above MSL)*	*Tsunami Height plus MSL*	*Tsunami Ht. Plus MSL Minus Site Elevation (Construction)*	*Tsunami Ht Plus MSL Minus Site Elev. Minus Containment and/or Topography (Operations)*	*Possible Flooding of the Site? (Const/Ops)*	*Possible Flooding of the Storage Tanks? (Const/Ops)*
Berths 238-240	14 feet plus 23-foot wall = 37ft	100 ft	2.8 ft	8.2 ft	11.0 ft	NA (No new construction)	-26 ft	NA/No (Intervening Topography)	NA/No
Note: * Tsunami height based on most likely worst-case scenario, which is a landslide off the Palos Verdes Peninsula. Tsunami run-up data is not available for Berths 76-78 and 84-87 within the Port of Long Beach.									

Table 3.5-6: No Federal Action/No Project Alternative Impacts at Shore and Backland Elevations

Theoretical Maximum Worst Case									
Site	*Site Elevation above MLLW Plus Containment*	*Distance from Shore*	*Highest Anticipated Tide (Height above MLLW)*	*Potential Tsunami Wave Height* (Above MSL)*	*Tsunami Height plus Highest Tide*	*Tsunami Ht plus HWL Minus Site Elevation (Construction)*	*Tsunami Plus HWL Minus Site Elev. Minus Containment and/or Topography (Operations)*	*Possible Flooding of the Site? (Const/Ops)*	*Possible Flooding of the Storage Tanks? (Const/Ops)*
Berths 238-240	14 feet plus 23-foot wall = 37 ft	100 ft	7.3 ft	8.2 ft	15.5 ft	NA (No new construction)	-21.5 ft	NA/No (Intervening Topography)	NA/No
Note: * Tsunami height based on most likely worst-case scenario, which is a landslide off the Palos Verdes Peninsula. Tsunami run-up data is not available for Berths 76-78 and 84-87 within the Port of Long Beach.									

For tanker vessels, the risk of tsunami or seiches is a part of any ocean-shore interface and hence vessels in transit or at berth cannot avoid some risk of exposure. A tanker vessel destined for the San Pedro Bay Ports would be under its own power and have one or more tugs in attendance. Under this circumstance, the vessel would likely be able to maneuver to avoid damage as it would with any ocean wave. The exposure of a tsunami or seiche to a vessel in transit to or from the proposed Project area berths, and the associated risk, is no different than for any other vessel entering the port complex.

Port engineers have indicated that currents moving over 5 meters per second (m/s) could potentially render a ship out of control (personal communication, J. Morgan, 2006). Modeling indicates that tsunami related currents created as a result of a large earthquake on the Santa Catalina Fault or submarine landslide off the coast of the nearby Palos Verdes Peninsula would not create currents in the Port in excess of 5 m/s. Highest anticipated current speeds of 2 m/s would occur in the vicinity of Pier 400 and the entrance to the main channel (Moffatt and Nichol 2007).

The current speeds in the Port of Long Beach would generally be higher than in the Port, as a result of a tsunami. In particular, the entrances to the Southeast Basin entrance and the Navy Basin entrance exceed 4 m/s. For the remaining areas within the Port of Long Beach, including Berths 76-78 and 84-87, almost all current speeds would be less than 1 m/s (Moffatt and Nichol 2007).

A tanker vessel docked at one of the berths would be subject to the rising and falling of the water levels and the accompanying currents during a tsunami or seiche. Two scenarios could arise. Either the vessel would stay secured to the berth and ride out the tsunami or the motion during a tsunami would cause the mooring lines of the vessel to break free and the vessel would be set adrift. In the first scenario, the energy of the tsunami wave would be transmitted through the vessel that is moored at berth and into the wharf. Forces transmitted through the vessel would be transferred to the fendering system of the wharf and then to the wharf structure.

The existing wharf fendering systems are designed with the assumption that, under a normal docking scenario, a berthing vessel will contact only one fender. For such scenarios, each fender is designed to absorb the berthing energy of the entire vessel. During a tsunami occurrence, the wave is assumed to move the vessel against more than one of the existing fenders, so that the vessel would be contacting a minimum of four to five fenders, often simultaneously. In such cases, the forces experienced by each fender during a tsunami are often less than the standard docking forces that the fendering system is designed, because more than one fender would absorb these forces at the same time. Therefore, substantial damage is not expected to the vessel or the wharf in the event that a tsunami was to strike while a vessel was secured at a berth.

Under the second scenario, a vessel set adrift in the Port area could have more serious consequences from the potential of collision, including a potential hull breach and possible fuel spill. This scenario is examined in Section 3.12, Risk of Upset/Hazardous Materials.

In accordance with MOTEMS, annual walk-down inspections must be completed at all marine terminals. In addition, MOTEMS related audits must be completed every three years for above water structures; every one to six years for underwater structures (based on the results of the annual inspection); and following significant events, such as earthquakes, flooding, fire, or vessel impact. Structural upgrades would subsequently occur, as necessary, based on the results of the audits. However, there is no established time frame for completion of the upgrades. The schedule would be determined by the California State Lands Commission, in combination with the terminal operator. Therefore, in the absence of established structural upgrade scheduling, aging marine terminals, such as LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87, would potentially be operating out of compliance with MOTEMS for at least some of the period subsequent to 2010. By comparison, new facilities at Pier 400 would be in compliance with all applicable MOTEMS from initiation of proposed Project operations.

CEQA Impact Determination

Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by the No Federal Action/No Project Alternative. However, because much of the Port is located 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches. Although less infrastructure would be susceptible to tsunami and seiche damage, aging marine terminals, such as LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87, would potentially be operating out of compliance with MOTEMS for at least some of the period subsequent to 2010, making those berths more susceptible to damage.

In addition, even with implementation of proper MOTEMS protocol, a vessel set adrift in the Port area could have serious consequences from the potential of collision, including a potential hull breach and possible oil spill. Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. As a result, impacts related to tsunamis and seiches would be significant and unavoidable under CEQA because the No Federal Action/No Project Alternative could expose people or property to substantial risk of tsunamis or seiches.

Mitigation Measures

MM GEO-1: Emergency Response Planning. The Terminal operator shall work with Port engineers and Port police to develop tsunami response training and procedures to assure that operations personnel will be prepared to act in the event of a large seismic event. Such procedures shall include immediate evacuation requirements in the event that a large seismic event is felt at the Port area, as part of overall emergency response planning.

Such procedures shall be included in any bid specifications for operations personnel, with a copy of such bid specifications to be provided to LAHD, including a completed copy of its operations emergency response plan prior to commencement of operations.

Residual Impacts

Emergency planning and coordination between the Terminal operator and the LAHD, as outlined in **MM GEO-1**, would contribute in reducing injuries to on-site personnel during a tsunami. However, even with incorporation of emergency planning, substantial damage and/or injury would occur in the event of a tsunami or seiche. Therefore, residual impacts would remain significant and unavoidable.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-3: The No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.

CEQA Impact Determination

In the absence of federal permits, in-water construction would not occur and no development would occur within the proposed Project area. Construction would be limited to paving of Tank Farm Sites 1 and 2, for use as part of adjacent container terminals. As discussed for **Impact GEO-3** of the proposed Project, subsidence in the vicinity of the proposed Project, due to previous oil extraction in the Port area, has been mitigated and is not anticipated to adversely impact the site. Impacts would be less than significant because the No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement. In addition, because construction would not occur in association with the No Project Alternative (with the exception of paving of Tank Farm Sites 1 and 2), impacts related to cracking and warping of structures during operations as a result of saturated, unconsolidated/compressible sediments would be less than significant.

In addition, since no construction would occur on Port of Long Beach Berths 76-78 and 84-87, nor LAHD Berths 238-240, there would be no construction impacts at these berths.

Mitigation Measures

As subsidence impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, there would be less than significant residual impacts.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-4: The No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from soil expansion.

CEQA Impact Determination

In the absence of federal permits, in-water construction would not occur and no development would occur within the proposed Project area. Construction would be limited to paving of Tank Farm Sites 1 and 2, for use as part of adjacent container terminals. Because the No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from soil expansion, impacts would be less than significant under CEQA.

In addition, since no construction would occur on Port of Long Beach Berths 76-78 and 84-87, nor LAHD Berths 238-240, there would be no construction impacts at these berths.

Mitigation Measures

As expansive soil impacts be less than significant, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, there would be less than significant residual impacts under this alternative.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-5: The No Federal Action/No Project Alternative would not result in or expose people or property to a substantial risk of landslides or mudslides.

CEQA Impact Determination

The topography in the vicinity of the site is flat and not subject to landslides or mudflows. No impacts would occur under CEQA because the No Federal Action/No Project Alternative would not result in or expose people or property to a substantial risk of landslides or mudslides. In addition, since no construction would occur on Port of Long Beach Berths 76-78 and 84-87, nor LAHD Berths 238-240, there would be no construction impacts at these berths.

Mitigation Measures

As landslide and mudslide impacts would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, there would be no residual impacts.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-6: Collapsible soils would have no impact under the No Federal Action/No Project Alternative and would not expose people or structures to substantial risk.

CEQA Impact Determination

Excavations would not be completed within the Project area under the No Federal Action/No Project Alternative. Impacts would not occur because collapsible soils would have no impact under the No Federal Action/No Project Alternative and would not expose people or structures to substantial risk. In addition, since no construction would occur on Port of Long Beach Berths 76-78 and 84-87, nor LAHD Berths 238-240, there would be no construction impacts at these berths.

Mitigation Measures

As impacts associated with collapsible soils would not occur, no mitigation measures are required.

Residual Impacts

With no mitigation required, there would be no residual impacts associated with collapsible soils.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-7: The No Federal Action/No Project Alternative would not result in one or more distinct and prominent geologic or topographic features being destroyed, permanently covered, or materially and adversely modified.

CEQA Impact Determination

No impacts would occur because the No Federal Action/No Project Alternative would not result in one or more distinct and prominent geologic or topographic features being destroyed, permanently covered, or materially and adversely modified.

In addition, since no construction would occur on Port of Long Beach Berths 76-78 and 84-87, nor LAHD Berths 238-240, there would be no construction impacts at these berths.

Mitigation Measures

As impacts due to removal of prominent geologic or topographic features would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, there would be no residual impacts.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

Impact GEO-8: Although the northern portion of the site is underlain by the Wilmington Oil Field, the No Federal Action/No Project Alternative would not result in the loss of availability of any mineral resource.

With respect to aggregate potential, the San Pedro Bay Ports are located in MRZ-1, which is defined as an area where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence. However, with respect to petroleum resources, the northern portion of the San Pedro Bay Ports is located within the Wilmington Oil Field.

CEQA Impact Determination

Use of LAHD Berths 238-240 and Port of Long Beach Berths 76-78 and 84-87, under the No Project Alternative, would continue to preclude oil and gas drilling from those berths; however, petroleum reserves beneath these berths could be accessed from remote locations, using directional (or slant) drilling techniques. Therefore, the No Federal Action/No Project Alternative would not result in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the state. Impacts would be less than significant because the No Federal Action/No Project Alternative would not result in the loss of availability of any mineral resource.

Mitigation Measures

As impacts associated with mineral resources would be less than significant, no mitigation measures are required.

Residual Impacts

With no mitigation required, the residual impacts are less than significant.

NEPA Impact Determination

Because the No Federal Action/No Project Alternative is identical to the NEPA Baseline in this project, under NEPA the No Federal Action/No Project Alternative would have no impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

With no mitigation required, there would be no residual impacts under NEPA.

3.5.4.3.3 Reduced Project Alternative

Under the Reduced Project Alternative, as described in Section 2.5.2.2, construction and operation at Berth 408 would be identical to the proposed Project with the exception of the lease cap limiting throughput in certain years. However, as explained in Section 2.5.2.2, the lease cap would not change the amount of crude oil demanded in southern California, and therefore the analysis of the Reduced Project Alternative also includes the impacts of marine delivery of incremental crude oil deliveries to existing liquid bulk terminals in the San Pedro Bay Ports in years where demand exceeds the capacity of the lease-limited Berth 408.

As described in Section 2.5.2.2, the impact assessment for the Reduced Project Alternative also assumes existing terminals would eventually comply with the MOTEMS, that the LAHD and the Port of Long Beach would renew the operating leases for existing marine terminals, and that existing terminals would comply with CAAP measures as of the time of lease renewal (i.e., 2008 for Port of Long Beach Berths 84-87, 2015 for LAHD Berths 238-240, and 2023 for Port of Long Beach Berths 76-78).

The following sections analyze the impacts of the Reduced Project Alternative relative to both the CEQA and NEPA Baselines.

Impact GEO-1: The Reduced Project Alternative would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

CEQA Impact Determination

Because of the proximity of the active Palos Verdes Fault, construction of the Marine Terminal and associated tanks and pipelines would expose people and property to substantial risk of fault rupture, seismic ground shaking, liquefaction, and other seismically induced ground failure. Earthquake-resistant standards were incorporated into the design of recently completed Pier 400 to reduce potential impacts from a major earthquake. Similarly, the proposed Marine Terminal and related infrastructure would be constructed in accordance with modern earthquake-resistant standards to reduce potential impacts from a major earthquake. However, as discovered during the 1971 San Fernando earthquake and the 1994 Northridge earthquake, existing building codes are sometimes inadequate to completely protect engineered structures from seismic impacts and other seismically induced hazards. As a result, exposure of people and property to substantial risk of injury from an earthquake during Reduced Project operations cannot be precluded, even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismicity would be significant and unavoidable.

Mitigation Measures

MM 4A-4, which requires completion of a site-specific geotechnical investigation, shall be applied to reduce potentially significant seismic impacts to property and on-site personnel.

Residual Impacts

Design and construction of existing facilities in accordance with recommendations of a site-specific geotechnical investigation, as well as applicable laws and regulations pertaining to seismically induced ground movement, would minimize structural damage in the event of an earthquake. However, increased exposure of people and property during operations to seismic hazards from a major or great earthquake cannot be precluded even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismically induced ground failure would remain significant with mitigation.

NEPA Impact Determination

Similar to the proposed Project, because of the proximity of the active Palos Verdes Fault, construction of the Marine Terminal and associated tanks and pipelines would expose people and property to substantial risk of fault rupture, seismic ground shaking, liquefaction, and other seismically induced ground failure. Earthquake-resistant standards were incorporated into the design of recently completed Pier 400 to reduce potential impacts from a major earthquake. Similarly, the proposed Marine Terminal and related infrastructure would be constructed in accordance with modern earthquake-resistant standards to reduce potential impacts from a major earthquake. However, as discovered during the 1971 San Fernando earthquake and the 1994 Northridge earthquake, existing building codes are sometimes inadequate to completely protect engineered structures from seismic impacts and other seismically induced hazards. As a result, exposure of people and property to substantial risk of injury from an earthquake during Reduced Project operations cannot be precluded, even with incorporation of modern construction engineering and safety standards. Therefore, potential impacts due to seismicity would be significant and unavoidable.

Mitigation Measures

MM 4A-4, which requires completion of a site-specific geotechnical investigation, shall be applied to reduce potentially significant seismic impacts to property and on-site personnel.

Residual Impacts

Design and construction of existing facilities in accordance with recommendations of a site-specific geotechnical investigation, as well as applicable laws and regulations pertaining to seismically induced ground movement, would minimize structural damage in the event of an earthquake. However, exposure of people and property during operations to seismic hazards from a major or great earthquake cannot be precluded even with incorporation of modern construction engineering and safety standards. Therefore, impacts due to seismically induced ground failure would remain significant and unavoidable.

Impact GEO-2: The Reduced Project could expose people or property to substantial risk of tsunamis or seiches.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

CEQA Impact Determination

Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by construction of the Reduced Project. However, because the Reduced Project elevation is located within 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches. Designing new facilities based on existing building codes may not prevent substantial damage to structures from coastal flooding. Projects in construction phases are especially susceptible to damage due to temporary conditions, such as unfinished structures, which are typically not in a condition to withstand coastal flooding.

In addition, even with implementation of proper MOTEMS protocol, a vessel set adrift in the Port area could have serious consequences from the potential of collision, including a potential hull breach and possible oil spill. Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. As a result, impacts would be significant and unavoidable under CEQA because the Reduced Project could expose people or property to substantial risk of tsunamis or seiches.

Mitigation Measures

MM GEO-1: Emergency Response Planning. The Terminal operator shall work with Port engineers and Port police to develop tsunami response training and procedures to assure that construction and operations personnel will be prepared to act in the event of a large seismic event. Such procedures shall include immediate evacuation requirements in the event that a large seismic event is felt at the Reduced Project site, as part of overall emergency response planning for this Reduced Project.

Such procedures shall be included in any bid specifications for construction or operations personnel, with a copy of such bid specifications to be provided to the LAHD, including a completed copy of its operations emergency response plan prior to commencement of construction activities and/or operations.

Residual Impacts

Emergency planning and coordination between the Terminal operator and the LAHD, as outlined in **MM GEO-1**, would contribute in reducing injuries to on-site personnel during a tsunami. However, even with incorporation of emergency planning and construction in accordance with current City and State regulations, substantial damage and/or injury would occur in the event of a tsunami or seiche. Therefore, residual impacts would remain significant and unavoidable.

NEPA Impact Determination

Impacts due to tsunamis and seiches are typical for the entire California coastline and would not be increased by construction of the Reduced Project. However, because the Reduced Project elevation is located within 15 feet (4.6 m) above MLLW, there is a substantial risk of coastal flooding due to tsunamis and seiches. Designing new facilities based on existing building codes may not prevent substantial damage to structures from coastal flooding. Projects in construction phases are especially susceptible to damage due to temporary conditions, such as unfinished structures, which are typically not in a condition to withstand coastal flooding.

In addition, even with implementation of proper MOTEMS protocol, a vessel set adrift in the Port area could have serious consequences from the potential of collision, including a potential hull breach and possible oil spill. Finally, if the tsunami were to occur during the unloading of crude oil, the rising and falling of the vessel could lead to failure of the loading arms and an oil spill. As a result, impacts would be significant and unavoidable under NEPA because the Reduced Project could expose people or property to substantial risk of tsunamis or seiches.

Mitigation Measures

MM GEO-1 shall be applied to the NEPA project impact determination to reduce tsunami and seiche related impacts.

Residual Impacts

Emergency planning and coordination between the terminal operator(s) and the LAHD, as outlined in **MM GEO-1**, would contribute in reducing injuries to on-site personnel during a tsunami. However, even with incorporation of emergency planning and construction in accordance with current City and State regulations, substantial damage and injury would occur in the event of a tsunami or seiche. Therefore, residual impacts would remain significant and unavoidable.

Impact GEO-3: The Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

Subsidence as a result of previous oil extraction in the Port area has been arrested as a result of water injection and is not anticipated to adversely impact the Reduced Project. However, in the absence of proper engineering, HDD operations associated with pipeline construction and dewatering operations completed for excavations could induce settlement in underlying, unconsolidated sediments. Foundations of existing structures and proposed structures built on these sediments, such as the large crude oil tanks, could be cracked and warped by such settlement.

However, during design, the settlement potential of existing onshore soils would be evaluated through a site-specific geotechnical investigation, which includes subsurface soil sampling, laboratory analysis of samples collected to determine soil compressibility, and an evaluation of the laboratory testing results, by a geotechnical engineer. Recommendations of the engineer would be incorporated into the design specifications for the Reduced Project, consistent with City design guidelines, including Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, in conjunction with criteria established by the LAHD and Caltrans.

Recommendations for soils subject to settlement typically include overexcavation and recompaction of compressible soils, which would allow for construction of a conventional slab-on-grade; or alternatively, installation of concrete or steel foundation piles through the settlement prone soils, to a depth of competent soils. Such engineering has been proposed for the tank farms, where installation of stone columns (made from compacted gravel) has been proposed for support under the tanks. Such geotechnical engineering would substantially reduce the potential for soil settlement and would ensure that construction of the Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

<u>CEQA Impact Determination</u>

Settlement impacts in onshore areas would be less than significant under CEQA, as the Reduced Project Alternative would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and Caltrans, and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

Because impacts would be less than significant, mitigation measures are not required. However, **MM 4A-6,** which requires completion of a site-specific geotechnical investigation, shall be applied to further reduce settlement impacts to property.

Residual Impacts

With completion of a site-specific geotechnical investigation and implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, the residual impacts would be less than significant under CEQA.

NEPA Impact Determination

Subsidence in the vicinity of the Reduced Project, due to previous oil extraction in the Port area, has been mitigated and is not anticipated to adversely impact the site. Impacts would be less than significant.

Settlement impacts in onshore areas would be less than significant under NEPA, as the Reduced Project Alternative would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and Caltrans, and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

Because impacts would be less than significant, mitigation measures are not required. However, **MM 4A-6,** which requires completion of a site-specific geotechnical investigation, shall be applied to further reduce settlement impacts to property.

Residual Impacts

With completion of a site-specific geotechnical investigation and implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, the residual impacts would be less than significant under NEPA.

Impact GEO-4: The Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from expansive soil.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

Pier 400 was constructed primarily with sandy material, thus reducing the potential for expansive soils in that portion of the Reduced Project area. However, expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula. Artificial fill soils along portions of the pipeline routes and at Tank Farm Site 2 could similarly be expansive. Use of expansive soils beneath Reduced Project foundations in these areas could result in cracking and distress of foundations. Existing structures built on these sediments could be cracked and warped by such settlement.

However, the soil expansion potential would be evaluated through a site-specific geotechnical investigation, which includes subsurface soil sampling, laboratory analysis of samples collected to determine soil expansion potential, and an evaluation of the laboratory testing results, by a geotechnical engineer. Recommendations of the engineer would be incorporated into the design specifications for the Reduced Project Alternative, consistent with City design guidelines, including Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, in conjunction with criteria established by the LAHD.

Recommendations for soils subject to expansion typically include overexcavation and replacement of expansive soils with sandy, non-expansive soils, which would allow for construction of a conventional slab-on-grade; construction of post-tensioning concrete slabs, which can accommodate movement of underlying expansive soils; or alternatively, installation of concrete or steel foundation piles through the expansion prone soils, to a depth of non-expansive soils. Such engineering has been proposed for the tank farms, where installation of stone columns (made from compacted gravel) has been proposed for support under the tanks. Such geotechnical engineering would substantially reduce the potential for soil expansion and damage to overlying structures.

CEQA Impact Determination

Expansive soil impacts in onshore areas would be less than significant under CEQA as the Reduced Project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

As expansive soil impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code resulting in no required mitigation, the residual impacts would be less than significant under CEQA.

NEPA Impact Determination

Expansive soil impacts in onshore areas would be less than significant under NEPA as the Reduced Project would be designed and constructed in compliance with the recommendations of the geotechnical engineer, consistent with implementation of Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, and in conjunction with criteria established by the LAHD and would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury.

Mitigation Measures

As expansive soil impacts would be less than significant, no mitigation measures are necessary.

Residual Impacts

With implementation of standard geotechnical engineering and Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, less than significant residual impacts would occur under NEPA.

Impact GEO-5: Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

The topography of the Reduced Project area is relatively flat; therefore, components of the Reduced Project would not be subject to onshore landslides or mudflows. The Marine Terminal would be built overlying recently completed submarine slopes of Pier 400. These slopes were constructed in accordance with current City of Los Angeles building codes, which include provisions of the Uniform Building Code. These engineered slopes will be capable of supporting the proposed Marine Terminal.

CEQA Impact Determination

The topography in the vicinity of the Reduced Project site is flat and not subject to landslides or mudflows. No impacts would occur under CEQA because the Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.

Mitigation Measures

As landslide and mudslide impacts would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under CEQA.

NEPA Impact Determination

The topography in the vicinity of the Reduced Project site is flat and not subject to landslides or mudflows. No impacts would occur under NEPA because the Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.

Mitigation Measures

As landslide and mudslide impacts would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, no residual impacts would occur under NEPA.

Impact GEO-6: Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions.

Impacts would be similar to those described for the proposed Project, as the Reduced Project Alternative would be identical to the proposed Project in terms of the design and construction, and similar in operation, of the Marine Terminal, Tank Farm Sites 1 and 2, and Pipeline Segments 1, 2a, 2b, 2c, 3, 4, and 5.

The Reduced Project may include temporary excavations for construction of the Marine Terminal and associated infrastructure. In addition, trenching would be completed in association with pipeline installation. The flat nature of the topography and the minimal grading required for each land site would minimize the height and size of temporary slopes. In addition, the slopes would be constructed in accordance with provisions of the OSHA.

CEQA Impact Determination

The topography is generally flat and temporary slopes would be constructed in accordance with provisions of OSHA. Impacts would be less than significant impacts under CEQA because the Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions.

Mitigation Measures

No mitigation measures are necessary.

Residual Impacts

With no mitigation required, less than significant residual impacts would occur under CEQA.

NEPA Impact Determination

The topography is generally flat and temporary slopes would be constructed in accordance with provisions of OSHA. Less than significant impacts would occur under NEPA because the Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions.

Mitigation Measures

As unstable soil conditions would not occur, no mitigation measures are necessary.

Residual Impacts

With no mitigation required, less than significant residual impacts would occur under NEPA.

Impact GEO-7: The Reduced Project Alternative would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

Impacts would be similar in type to the proposed Project, i.e., no impacts would occur. The Reduced Project areas are relatively flat, with no distinct geologic or topographic features. In addition, the areas are underlain primarily by fill material, which was derived either from Port dredging activities or from imported fill. Therefore, no impacts would occur.

CEQA Impact Determination

No impacts would occur under CEQA because the Reduced Project Alternative would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

Mitigation Measures

No mitigation is required.

Residual Impacts

No impacts are anticipated under CEQA.

NEPA Impact Determination

No impacts would occur under NEPA because the Reduced Project Alternative would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.

Mitigation Measures

No mitigation is required.

Residual Impacts

No residual impacts are anticipated under NEPA.

Impact GEO-8: The Reduced Project Alternative would not result in the loss of availability of a known mineral resource.

Impacts would be similar in type to the proposed Project. With respect to aggregate potential, the Reduced Project site, including the tank farm sites, is located in MRZ-1, which is defined as an area where adequate information indicates that no significant mineral deposits are present or where it is judged that little likelihood exists for their presence. However, with respect to petroleum resources, the northern portion of the

Reduced Project area is located within the Wilmington Oil Field. The northern section of proposed pipeline, between Berth 174 and the Ultramar/Valero Refinery, would preclude oil and gas drilling along the immediate pipeline right-of-way.

CEQA Impact Determination

Reduced Project construction would preclude oil and gas drilling from within Reduced Project boundaries; however, petroleum reserves beneath the site could be accessed from remote locations, using directional (or slant) drilling techniques. Therefore, the Reduced Project would not result in the permanent loss of availability of a known mineral resource that would be of future value to the region and the residents of the state. Mineral resource impacts would be less than significant under CEQA.

Mitigation Measures

As impacts associated with mineral resources would be less than significant, no mitigation measures are required.

Residual Impacts

With no mitigation required, the residual impacts are less than significant under CEQA.

NEPA Impact Determination

Reduced Project construction would preclude oil and gas drilling from within Reduced Project boundaries; however, petroleum reserves beneath the site could be accessed from remote locations, using directional (or slant) drilling techniques. Therefore, the Reduced Project would not result in the permanent loss of availability of a known mineral resource that would be of future value to the region and the residents of the state. Mineral resource impacts would be less than significant under NEPA.

Mitigation Measures

As impacts associated with mineral resources would be less than significant, no mitigation measures are required.

Residual Impacts

With no mitigation required, the residual impacts would be less than significant under NEPA.

3.5.4.3.4 Summary of Impact Determinations

The following Table 3.5-7 summarizes the CEQA and NEPA impact determinations of the proposed Project and its alternatives related to Geology, as described in the detailed discussion in Sections 3.5.4.3.1 through 3.5.4.3.3. This table is meant to allow easy comparison between the potential impacts of the proposed Project and its alternatives with respect to this resource. Identified potential impacts may be based on Federal, State, or City of Los Angeles significance criteria, Port criteria, and the scientific judgment of the report preparers.

Table 3.5-7. Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project and Alternatives

Alternative	*Environmental Impacts*	*Impact Determination*	*Mitigation Measures*	*Impacts after Mitigation*
3.5 Geology				
Proposed Project	**GEO-1:** The proposed Project would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.	CEQA: **Significant** impact NEPA: **Significant** impact	**MM 4A-4:** Seismic Design **MM 4A-4**	CEQA: **Significant** and unavoidable impact NEPA: **Significant** and unavoidable impact
	GEO-2: The proposed Project could expose people or property to substantial risk of tsunamis or seiches.	CEQA: **Significant** impact NEPA: **Significant** impact	**MM GEO-1:** Emergency Response Planning **MM GEO-1**	CEQA: **Significant** and unavoidable impact NEPA: **Significant** and unavoidable impact
	GEO-3: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.	CEQA: Less than significant impact NEPA: Less than significant impact	**MM 4A-6:** Minimization of Settlement **MM 4A-6**	CEQA: Less than significant impact NEPA: Less than significant impact
	GEO-4: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from expansive soil.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact
	GEO-5: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-6: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions from excavations, grading, or fill.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact

Table 3.5-7. Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project and Alternatives (continued)

Alternative	*Environmental Impacts*	*Impact Determination*	*Mitigation Measures*	*Impacts after Mitigation*
3.5 Geology (continued)				
Proposed Project (continued)	**GEO-7:** The proposed Project would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-8: The proposed Project would not result in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the state.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact
No Federal Action/No Project Alternative	**GEO-1:** The No Federal Action/No Project Alternative would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.	CEQA: **Significant** impact NEPA: No impact	Mitigation not applicable Mitigation not required	CEQA: **Significant** and unavoidable impact NEPA: No impact
	GEO-2: The No Federal Action/No Project Alternative could expose people or property to substantial risk of tsunamis or seiches.	CEQA: **Significant** impact NEPA: No impact	**MM GEO-1** Mitigation not required	CEQA: **Significant** and unavoidable impact NEPA: No impact
	GEO-3: The No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.	CEQA: Less than significant impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: No impact
	GEO-4: The No Federal Action/No Project Alternative would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from soil expansion.	CEQA: Less than significant impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: No impact

Table 3.5-7. Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project and Alternatives (continued)

Alternative	*Environmental Impacts*	*Impact Determination*	*Mitigation Measures*	*Impacts after Mitigation*
		3.5 Geology (continued)		
No Federal Action/No Project Alternative (continued)	**GEO-5:** The No Federal Action/No Project Alternative would not result in or expose people or property to a substantial risk of landslides or mudslides.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-6: Collapsible soils would have no impact under the No Federal Action/No Project Alternative and would not expose people or structures to substantial risk.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-7: The No Federal Action/No Project Alternative would not result in one or more distinct and prominent geologic or topographic features being destroyed, permanently covered, or materially and adversely modified.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-8: Although the northern portion of the site is underlain by the Wilmington Oil Field, the No Federal Action/No Project Alternative would not result in the loss of availability of any mineral resource.	CEQA: Less than significant impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: No impact
Reduced Project Alternative	**GEO-1:** The Reduced Project Alternative would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.	CEQA: **Significant** impact NEPA: **Significant** impact	**MM 4A-4** **MM 4A-4**	CEQA: **Significant** and unavoidable impact NEPA: **Significant** and unavoidable impact
	GEO-2: The Reduced Project could expose people or property to substantial risk of tsunamis or seiches.	CEQA: **Significant** impact NEPA: **Significant** impact	**MM GEO-1** **MM GEO-1**	CEQA: **Significant** and unavoidable impact NEPA: **Significant** and unavoidable impact

Table 3.5-7. Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project and Alternatives (continued)

Alternative	*Environmental Impacts*	*Impact Determination*	*Mitigation Measures*	*Impacts after Mitigation*
3.5 Geology (continued)				
Reduced Project Alternative (continued)	**GEO-3:** The Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement.	CEQA: Less than significant impact NEPA: Less than significant impact	**MM 4A-6** **MM 4A-6**	CEQA: Less than significant impact NEPA: Less than significant impact
	GEO-4: The Reduced Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from expansive soil.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact
	GEO-5: Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from landslides or mudflows.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-6: Reduced Project construction would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from unstable soil conditions.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact
	GEO-7: The Reduced Project Alternative would not result in the destruction, permanent covering, or material and adverse modification of one or more distinct and prominent geologic or topographic features.	CEQA: No impact NEPA: No impact	Mitigation not required Mitigation not required	CEQA: No impact NEPA: No impact
	GEO-8: The Reduced Project Alternative would not result in the loss of availability of a known mineral resource.	CEQA: Less than significant impact NEPA: Less than significant impact	Mitigation not required Mitigation not required	CEQA: Less than significant impact NEPA: Less than significant impact

For each type of potential impact, the table describes the impact, notes the CEQA and NEPA impact determinations, describes any applicable mitigation measures, and notes the residual impacts (i.e.: the impact remaining after mitigation). All impacts, whether significant or not, are included in this table. Note that impact descriptions for each of the alternatives are the same as for the proposed Project, unless otherwise noted.

3.5.4.4 Mitigation Monitoring

With respect to seismicity, there are no mitigation measures available that would reduce significant impacts associated with seismically induced ground failure to less than significant levels.

Mitigation Measures from the Deep Draft Final EIS/EIR (1992) that Apply to this proposed Project:

The following Mitigation Measures were developed in the Deep Draft FEIS/FEIR to reduce the significant geologic impacts. These measures remain applicable to the current proposed Project. The following measures would be adopted by the Port Board of Harbor Commissioners and would become conditions of proposed Project approval that dictate future development of the proposed Project site:

Impact GEO-1: The proposed Project would expose people or property to substantial risk of fault rupture, seismic ground shaking, liquefaction, or other seismically induced ground failure.	
MM 4A-4: Seismic Design.	
Mitigation Measure	The proposed terminal facilities would have the potential to experience severe seismically induced ground accelerations. Damage or injury shall be minimized through the appropriate seismic engineering design, based upon a site-specific geotechnical investigation.
Timing	Prior to construction and/or operation
Methodology	A site-specific geotechnical investigation shall be completed by a California-licensed geotechnical engineer and/or engineering geologist. The results shall be incorporated into the structural design of Project components.
Responsible Parties	LAHD
Residual Impacts	Significant after mitigation.
Impact GEO-3: The proposed Project would not result in substantial damage to structures or infrastructure, or expose people to substantial risk of injury from subsidence/soil settlement. (Because impacts would be less than significant, mitigation measures are not required. However, the following mitigation measure from the Deep Draft FEIS/FEIR would further reduce the potential for impacts.)	
MM 4A-6: Minimization of Settlement.	
Mitigation Measure	The proposed terminal facilities would have the potential to experience soil settlement as a result of construction on hydraulically-placed landfill material. Damage or injury shall be minimized through the appropriate structural design, based upon a site-specific geotechnical investigation.
Timing	Prior to construction and/or operation
Methodology	A site-specific geotechnical investigation shall be completed by a California-licensed geotechnical engineer and/or engineering geologist. The results shall be incorporated into the structural design of Project components.
Responsible Parties	LAHD
Residual Impacts	Less than significant after mitigation.

Mitigation Measures Developed in this Draft SEIS/SEIR Specific to the Proposed Project:

In instances where the **MM GEO-1** Emergency Response Planning is necessary, the Terminal operator shall work with Port engineers and Port police to develop tsunami response training and procedures to assure that construction and operations personnel will be prepared to act in the event of a large seismic event.

Impact GEO-2: The proposed Project could expose people and property to substantial risk involving tsunamis or seiches.	
MM GEO-1: Emergency Response Planning.	
Mitigation Measure	The Terminal operator shall work with Port engineers and Port police to develop tsunami response training and procedures to assure that construction and operations personnel will be prepared to act in the event of a large seismic event. Such procedures shall include immediate evacuation requirements in the event that a large seismic event is felt at the proposed Project site, as part of overall emergency response planning for this proposed Project:
Timing	Prior to Construction and/or operation
Methodology	Such procedures shall be included in any bid specifications for construction or operations personnel, with a copy of such bid specifications to be provided to the LAHD, including a completed copy of its operations emergency response plan prior to commencement of construction activities and/or operations. Such procedures shall include immediate evacuation requirements in the event that a large seismic event is felt at the proposed Project site, as part of overall emergency response planning for this proposed Project
Responsible Parties	LAHD
Residual Impacts	Significant after mitigation.