Section 3.5

Geology

SECTION SUMMARY

This section presents the geologic conditions for the proposed Project area and analyzes: (1) seismic hazards including surface rupture, ground shaking, liquefaction, subsidence, tsunamis, seiches, and sea level rise; (2) other geologic issues including potentially unstable soils and slopes. This evaluation is based on published reports, applicable computer software programs, and the general geologic setting as indicators of potential geologic hazards. While most impact sections in this EIR look at the potential impact the proposed Project could have on the affected resource area, impacts are also determined on whether the geological process could cause additional environmental impacts as a result of implementation of the proposed Project. This difference is because geological processes such as earthquakes could occur independent of the proposed Project. An analysis of potential impacts on geologic issues associated with the alternatives is detailed in Chapter 6, Analysis of Alternatives.

Section 3.5, Geology, provides the following:

- A description of existing geological setting in both the Port and Project area;
- A description of geological processes such as faults, tsunamis, and subsidence;
- A discussion on the methodology used to determine whether the proposed Project would result in an impact to geological resources or whether the impacts of geological hazards on components of the proposed Project result in an impact to structures or expose people to risk of injury;
- An impact analysis of the proposed Project; and
- A description of any mitigation measures proposed to reduce any potential impacts, if applicable.

Key Points of Section 3.5:

The proposed Project lies approximately 1,600 feet west of the nearest Palos Verdes fault trace, which would result in a slight increase in the exposure of people and property to earthquake-related hazards. The Project site does not fall within a designated Alquist-Priolo Special Study fault zone. However, as a result of the site's close proximity to the fault trace, strong-to-intense ground shaking, surface rupture, and liquefaction could occur on or in the vicinity of the site, due to the proximity of the fault line and the presence of water-saturated hydraulic fill. With the exception of ground rupture, similar seismic impacts could occur due to earthquakes on other regional faults. The Los Angeles Basin, including Fish Harbor, is an area of known seismic activity. The Los Angeles region cannot avoid seismic hazards, such as liquefaction, ground rupture, ground acceleration, and ground shaking. In addition, given that hydraulic fill soils were used to create the Port and harbor facilities, expansive soils may also be present in the Project area. Although the proposed Project features do not have the potential to accelerate geologic hazards, the harbor area cannot avoid these hazards where the Palos Verdes fault zone is present, and hydraulic and alluvial fill is pervasive.

With implementation of applicable building codes, regulations and modern engineering and safety standards, construction and operation of the proposed Project would not expose people and structures to potential substantial adverse effects, including the risk of loss, injury, or death, related to surface rupture, ground shaking, and liquefaction.

Design and construction in accordance with applicable laws and regulations pertaining to seismically induced ground movement would minimize structural damage in the event of an earthquake. Therefore, potential impacts due to seismically induced ground failure (i.e., surface rupture, ground shaking, and liquefaction) would be less than significant for the proposed Project.

3.5.1 Introduction

This section presents the existing regional and local geologic and seismic conditions within the Project area and evaluates the impact of these conditions on the proposed Project development. This section presents the analysis of geologic processes including earthquakes and faults, seismic hazards including surface rupture, ground shaking, liquefaction, landslides, tsunamis, seiches, sea level rise, and subsidence. The analysis is based on a review of published reports, surface reconnaissance, and the general geologic setting of potential geologic hazards in the Project vicinity. This section also describes the existing conditions of soil resources in the Project area, including soil contamination, and evaluates the impact of these conditions on the proposed Project development.

3.5.2 Environmental Setting

3.5.2.1 Regional Setting

The proposed Project is located within the Los Angeles Basin between the central Transverse Ranges and the northern Peninsular Range geomorphic provinces (Yerkes et al. 1965). Quaternary and Neogene deposits make up most of the regional vicinity.[1] The Project area is located on artificial fill placed over Holocene alluvial sands and silts from recent and Pleistocene river action as outwash from the Los Angeles Basin.[2] The Los Angeles Basin is bounded to the east by the Newport-Inglewood fault zone and to the west by the Palos Verdes fault zone and Pacific Ocean. As shown in Figure 3.5-1, the Project site is located in a tectonically and seismically active region characterized by several active fault zones, and other geologic hazards that are characteristic of seismically active areas.

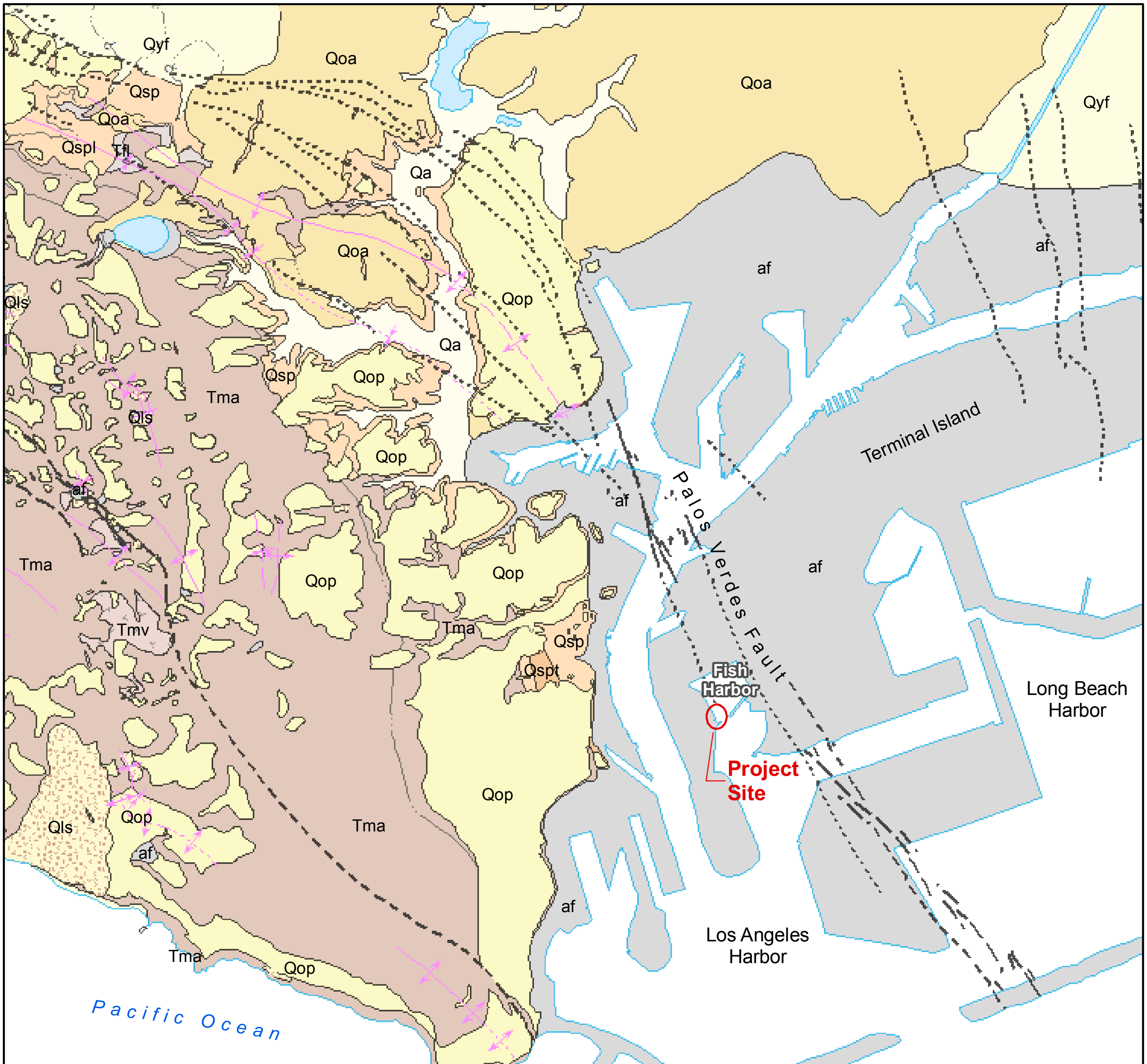
3.5.2.2 Seismicity and Major Faults

3.5.2.2.1 Faults

The Los Angeles Basin is cut by several active faults in the vicinity of the proposed Project. Segments of the active Palos Verdes fault zone cross the Los Angeles Harbor (Figure 3.5-1). The Palos Verdes Fault zone is the closest fault zone to the Project site, with the nearest fault trace passing approximately 1,600 feet to the east of the Project site. Recent studies indicate that the maximum credible earthquake (MCE) for the Palos Verdes fault zone is Richter magnitude 7.25, with a recurrence interval of 900 years and

[1] The **Quaternary period** is the youngest of three periods of the Cenozoic era in the geologic time scale. It follows after the Neogene period, spanning 2.588 +/- 0.005 million years ago to the present. Quaternary includes two geologic epochs: the Pleistocene and the Holocene epochs. The **Neogene** is a geologic period and system starting 23.03 ± 0.05 million years ago and lasting until 2.588 million years ago with the beginning of the Quaternary period. Quaternary and Neogene deposits refer to the geologic materials that were being deposited during the respective time periods.

[2] The **Pleistocene** is the epoch from 2.588 million to 12,000 years BP covering the world's recent period of repeated glaciations (2.588 +/- 0.005 million years ago to the present.



Legend

- Anticline
- Syncline
- Fault, identity and existence certain
- water
- af Artificial fill
- Qls Landslide eeposits
- Qa Alluvial flood plain deposits
- Qyf Young alluvial fan and valley deposits, undivided
- Qoa Old alluvial flood plain deposits, undivided
- Qop Old paralic deposits, undivided
- Qsp Altamira Shale Member
- Qspt Timms Point Silt Member
- Tfl Fernando Formation Lower Member
- Tma Monterey Formation Altamira Shale Member
- Tmv Miocene volcanic rocks

Source: California Geological Survey (2010) Geologic Compilation of Quaternary Surficial Deposits in Southern California

N

2,000 0 2,000

Feet

CDM Smith

Port of Los Angeles
Al Larson Boat Shop Improvement Project
Geologic and Palos Verdes Fault Zone Map
Figure 3.5-1

peak ground accelerations in the Port area of 0.28g and 0.52g, for the Operational Level Earthquake (OLE) and Contingency Level Earthquake (CLE), respectively (EMI, 2006; McNeilan et al., 1996).[3,4,5]

The probability of a moderate or major earthquake along the Palos Verdes fault zone is low (LAHD, 1980). However, this fault is capable of producing strong to intense ground motion and ground surface rupture. This fault zone has not been placed by the California Geological Survey into an Alquist-Priolo Earthquake Fault Zone. However, a portion of the Palos Verdes fault zone is identified as a Fault Rupture Study Area in the City of Los Angeles General Plan, Safety Element (City of Los Angeles, 1996). The Project area is located approximately 0.5 mile southwest of the Fault Rupture Study Area.

Active northwest-trending fault zones near the Project area include the Whittier-Elsinore, Newport-Inglewood, and Palos Verdes fault zones. Active east-west trending fault systems include the Malibu-Santa Monica-Raymond Hill fault system at the northern edge of the basin as shown in Figure 3.5-2. Table 3.5-1 presents an overview of these major regional faults along with the anticipated earthquake magnitudes. Based on the proximity and number of known regional faults, it is possible that a strong ground motion seismic event may occur in the Project area during the lifetime of the proposed Project.

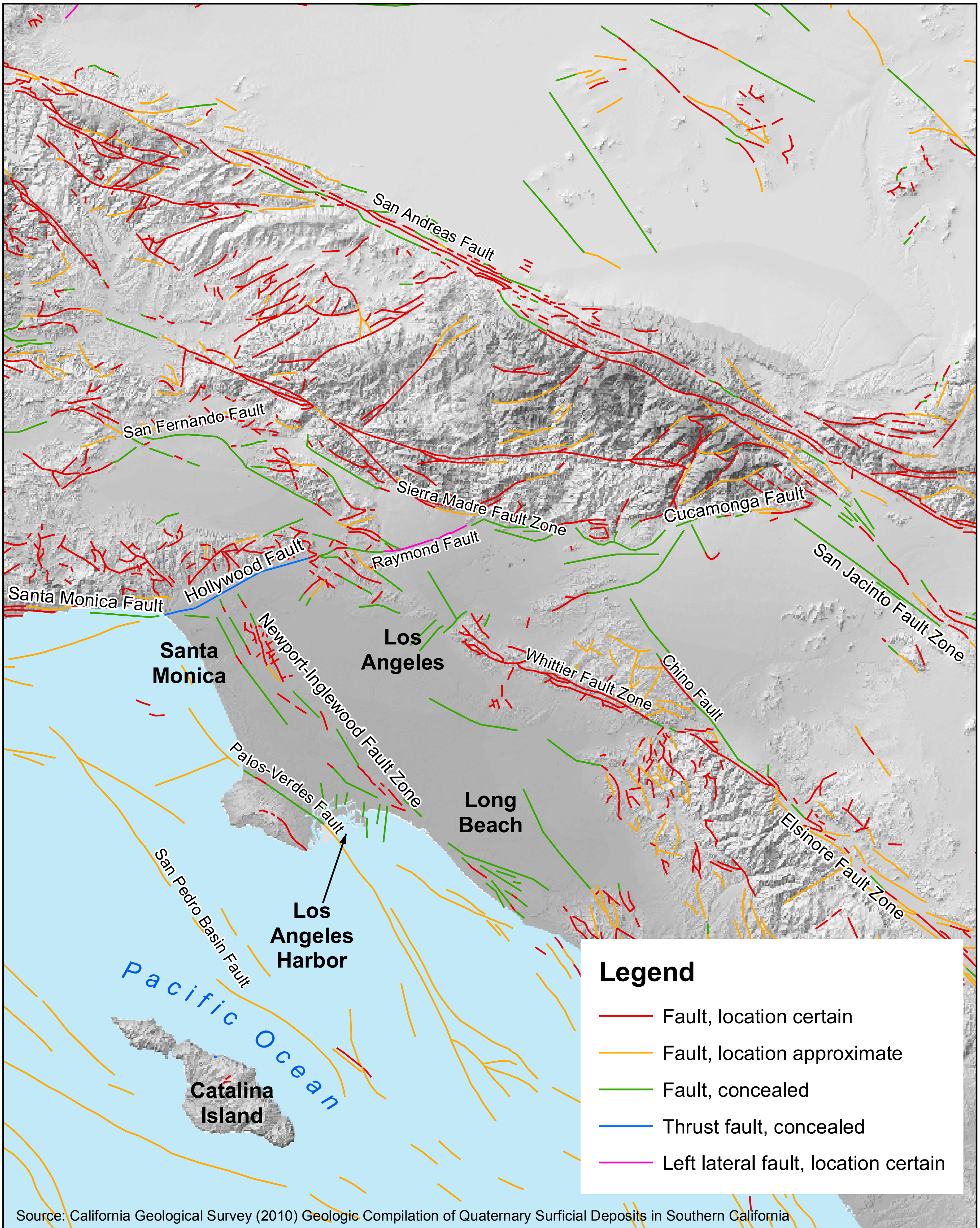
Active faults, such as those noted above, are typical of southern California. Therefore, it is reasonable to expect a strong ground motion seismic event during the lifetime of the proposed Project in the region. Numerous active faults located off site are capable of generating earthquakes that would impact the Project area (Tables 3.5-1 and 3.5-2). Most noteworthy, due to its proximity to the site, is the Newport-Inglewood fault zone, which has generated earthquakes of magnitudes up to 6.4 on the Richter scale (Southern California Earthquake Data Center, 2011). Large events could occur in the general area on more distant faults, but because of the greater distance from the site, earthquakes generated on these faults could be less significant with respect to ground accelerations.

In order to consider the effect of these local and regional faults, a deterministic seismic hazard analysis (DSHA) was conducted using the computer model EQFAULT (Blake, 2000). The analysis was performed using the attenuation relationships by Boore et al (1997), Campbell & Bozorgnia (1997 Rev), and Sadigh (1997) with a median uncertainty level. The average values of each attenuation relationship at each location for each fault within 60 miles of the site are presented in Table 3.5-3. The table also includes the average relative fault-to-site distances, estimated maximum moment magnitude, and estimated peak ground acceleration.

[3] MCE is the largest event a fault is believed to be capable of generating.

[4] OLE is the peak horizontal firm ground acceleration with a 50 percent probability of exceedance in 50 years

[5] CLE is the peak ground acceleration with a 10 percent probability of exceedance in 50 years.



CDM Smith

Port of Los Angeles
Al Larson Boat Shop Improvement Project
Major Regional Faults in Southern California
Figure 3.5-2

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 zone	[a]	[a]
San Pedro Basin fault	[a]	[a]
Santa Monica-Raymond fault	1855	6.0
San Andreas fault	1857 1952	8.2 7.7
Newport-Inglewood fault zone	1933	6.4
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, Southern California Earthquake Data Center, 2011.

[a] No known earthquakes have occurred within the last 200 years

Table 3.5-2: Hazardous Faults and Magnitudes— Los Angeles Basin Area

Fault Name	Distance in miles	Richter Magnitude (Ziony, 1985)	Maximum Credible Earthquake Magnitude (Greensfelder, 1974)	Duration in seconds (Bolt, 1973)
Palos Verdes fault zone	<1	6.4-6.6	7.25*	26
Newport-Inglewood fault zone	7	6.5-6.7	7	26
San Pedro Basin fault	15	6.3-6.6	no data	18
Whittier-Elsinore fault zone	22	6.4-6.7	7.5	16
Santa Monica-Raymond fault	24	6.2-6.6	7.5	15
San Fernando-Cucamonga fault	31	6.4-6.5	6.5	14
San Jacinto fault	57	6.4-7.0	7.5	22
San Andreas fault zone	54	7.2-8.1	8.25	28

Source: Ninyo & Moore, 1992; *EMI, 2006

Table 3.5-3: Deterministic Seismic Hazard Analysis Results

Abbreviated Fault Name	Distance (Miles)	Estimated Max Magnitude (M_w)	Estimated Peak Site Acceleration (g)
Palos Verdes	0.9	7.3	0.577
Newport-Inglewood (La Basin)	6.8	7.1	0.340
Puente Hills Blind Thrust	16.7	7.1	0.212
San Joaquin Hills	18.7	6.6	0.142
Newport-Inglewood (Offshore)	21.9	7.1	0.139
Whittier	22.2	6.8	0.113
Upper Elysian Park Blind Thrust	23.1	6.4	0.100
Santa Monica	24.6	6.6	0.107
Hollywood	26.0	6.4	0.088
Malibu Coast	26.1	6.7	0.107
Raymond	27.0	6.5	0.090
Verdugo	28.7	6.9	0.110
Anacapa-Dume	31.2	7.5	0.146
Chino-Central Ave. (Elsinore)	32.4	6.7	0.085
Sierra Madre	33.0	7.2	0.115
Northridge (E. Oak Ridge)	33.1	7.0	0.101
Clamshell-Sawpit	34.3	6.5	0.070
Elsinore (Glen Ivy)	36.4	6.8	0.068
Sierra Madre (San Fernando)	38.2	6.7	0.071
San Gabriel	40.4	7.2	0.080
Santa Susana	43.0	6.7	0.062
Holser	47.8	6.5	0.048
Oak Ridge (Onshore)	50.7	7.0	0.063
San Andreas - 1857 Rupture M-2a	54.3	7.8	0.088
San Andreas - Cho-Moj M-1b-1	54.3	7.8	0.088
San Andreas - Mojave M-1c-3	54.3	7.4	0.067
San Andreas - Whole M-1a	54.3	8.0	0.101
San Jacinto-San Bernardino	55.5	6.7	0.040
San Cayetano	57.0	7.0	0.056
San Andreas - SB-Coach. M-1b-2	57.9	7.7	0.077
San Andreas - SB-Coach. M-2b	57.9	7.7	0.075
San Andreas - San Bernardino M-1	57.9	7.5	0.068
Oak Ridge(Blind Thrust Offshore)	59.6	7.1	0.057
Channel Is. Thrust (Eastern)	60.6	7.5	0.073

Source: EQFAULT, 2000

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. The Alquist-Priolo Earthquake Fault Zoning Act does not currently zone faults in the area of the Port; however, there is evidence that the Palos Verdes fault zone may be active and could result in ground rupture at the site in the event of a large-scale earthquake (Fischer et al., 1987; McNeilan et al., 1996).

3.5.2.2.2 Liquefaction

According to the *L.A. CEQA Thresholds Guide* (City of Los Angeles, 2006), liquefaction is a form of earthquake-induced ground failure that occurs primarily in relatively shallow, loose, granular, water-saturated soils. Liquefaction is defined as the transformation of a granular material from a solid state into a liquefied state because of increased pore pressure, which results in the loss of grain-to-grain frictional resistance. Seismic ground shaking is capable of providing the mechanism for liquefaction, usually in fine-grained, loose to medium dense, saturated sands and silty sand. Unconsolidated silts, sands, and silty sands are most susceptible to liquefaction. While almost any saturated granular soil can develop increased pore water pressures when shaken, these excess pore water pressures can lead to liquefaction if the intensity and duration of earthquake shaking are great enough. During ground shaking, loose saturated soils can undergo liquefaction, and differential settlement of buildings and structures can occur.

Natural drainages at Port berths have been backfilled with undocumented fill materials. Dredged materials from the harbor area were spread across lower Wilmington from 1905 until 1910 or 1911 (Ludwig, 1927). In addition, the natural alluvial deposits below the adjacent sites are generally unconsolidated, soft, and saturated.

Groundwater depth is not currently available for the Project site; however, reports from adjacent sites such as the Southwest Marine Terminal (Berth 240 or 240Z) located at 985 S. Seaside Avenue and the Mobil Southwest/ExxonMobil Terminal (Berths 238-240C) located at 799 S. Seaside Avenue, have reported groundwater depths in the vicinity (i.e., within 1,000 feet of the Project site). There are currently 16 groundwater monitoring wells at the ExxonMobil site (SWRCB, 2010).[6] Groundwater depth recorded at these monitoring wells range from 7.4 to 11.2 feet bgs. Groundwater beneath the adjacent Southwest Marine Terminal has been recorded at depths ranging from 6 to 8.5 feet bgs (POLA, 2006). The groundwater beneath the ExxonMobil/General Petroleum facility has varied from 3 to 8 feet bgs, depending on the recent rainfall infiltration rates.

The groundwater depth, gradient, and flow direction, are subject to variation as a result of tidal influences. These conditions are considered conducive to liquefaction. 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 City of Los Angles General Plan, Safety Element identifies the proposed Project site as an area susceptible to liquefaction, or specifically as a “Liquefiable Area” due to the presence of recent alluvial deposits and groundwater less than 30 feet bgs (City of Los Angeles, 1996). Given that the subsurface within the Project site is composed of saturated sediment, artificial fill,

[6] Data are currently available through the SWRCB’s GeoTracker database system available at http://geotracker.swrcb.ca.gov/search.asp. Data can be queried by searching the Global ID No. for the Southwest Marine Terminal (SL092513) and the ExxonMobil Terminal (SL204701660).

and dredge spoils (Ludwig, 1927; POLA, 2006), there is potential for liquefaction to occur beneath the Project site during ground shaking. It has been suggested that the liquefaction potential in the Harbor area during a major earthquake along the San Andreas zone or the Newport-Inglewood fault zone is high (Tinsley and Youd, 1985; Toppozada et al., 1988; Davis et al., 1982). Other authors indicate that the overall probability of widespread liquefaction of un-compacted hydraulic fills and major damage in the Port is relatively low; however, even minor damage resulting from liquefaction can be very significant in terms of loss of functionality and repair costs (Pyke, 1990).

3.5.2.2.3 Tsunamis

Tsunamis are gravity waves of long wavelength generated by a sudden disturbance in a body of water. Tsunamis, like tides, produce waves of water that move inland, but in the case of tsunami the inland movement of water is much greater and lasts for a longer period than normal tides, giving the impression of an incredibly high tide. Typically, oceanic tsunamis are the result of sudden vertical movement along a fault rupture in the ocean floor, submarine landslides, subsidence, or volcanic eruption, where the sudden displacement of water sets off transoceanic waves with wavelengths of up to 125 miles 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, run-up of broken tsunamis in the form of bores and surges or by relatively dynamic flood waves my cause coastal flooding in the event of a large submarine earthquake or landslide. In the process of bore/surge-type run-up, the onshore flow (up to tens of feet 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. As has been shown historically, the potential loss of human life in the process can be great if such events occur in populated areas.

Abrupt sea level changes associated with tsunamis in the past have reportedly caused damage to moored vessels in the outer portions of the 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. Seriously damaged small craft moorings were in the Harbor area, especially in the Cerritos Channel where a seiche occurred. 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 rapid 6-foot rise of water were observed in the West Basin. The maximum water level fluctuations recorded by gauges were 5.0 feet at Port Berth 60 (near Pilot Station) and 5.8 feet in Long Beach Harbor (National Geophysical Data Center, 1993). Until recently, projected tsunami run-ups along the western U.S. were based on far-field events, such as submarine earthquakes or landslides occurring at great distances from the U.S., as described for the Chilean earthquake of May 1960.

Based on such distant sources, tsunami-generated wave heights ranging from 6.5 to 8 feet above mean lower low water (MLLW) at 100-year intervals, and ranging from 10 to 11 feet at 500-year intervals were projected, which included the effects of astronomical tides (Houston, 1980). The MLLW is a benchmark from which infrastructure (e.g., wharf and berth heights) is measured in the Port, and mean sea level (MSL) is +2.8 feet above MLLW (NOAA, 2011). Houston (1980) used these run-up estimates for the tsunami analysis contained in the Deep Draft Navigation Improvements EIR/EIS in September 1992 (USACE and LAHD, 1992).

In addition, landslide-derived tsunamis are now perceived as a viable local tsunami hazard. Such tsunamis potentially can be more dangerous, due to the lack of warning for such an event. An earthquake illustrated this mechanism in 1998, centered onshore in Papua-New Guinea, which appears to have created an offshore landslide that caused tsunami inundation heights in excess of 33 feet, 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 there are numerous mapped submarine landslides off 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. (2004) indicated 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-foot 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 based on near-field events for the Ports of Los Angeles and Long Beach. Offshore faults present a larger local tsunami hazard than previously thought, posing a direct threat to near-shore facilities. For example, the Santa Catalina fault is one of the largest such features and lies directly underneath Catalina Island, located only 22 miles from the Port. Simulations of tsunamis generated by uplift on this fault suggest waves in the Port in excess of 12 feet, with an arrival time within 20 minutes (Legg et al., 2003; Borrero et al., 2005). These simulations were based on rare events, representing worst-case scenarios. The CSLC estimates tsunami run-ups to be approximately 8.0 to15.0 feet above MSL at 100- and 500-year intervals, respectively, as part of their Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS) (CSLC, 2004). 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 Port Complex in its predictions of tsunami wave heights.

Most recently, a model has been developed specifically for the 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). 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. More specifically, the potential seismic tsunamigenic sources include: two scenarios based on a moment magnitude 7.6 earthquake on the Santa Catalina fault (Segments 1-7 and Segments 5-7); one scenario based on a magnitude 7.1 earthquake on the Palos Verdes fault near the Lasuen Knoll; one scenario based on a magnitude 7.0 earthquake on the San Mateo thrust fault; one scenario based on a magnitude 9.2 earthquake on the Cascadia subduction zone located in the Pacific Northwest; and two landslide events based on the Palos Verdes Escarpment located south of the Port. This model indicates that a reasonable maximum source for future tsunami events at the Project site would either be an earthquake on the Santa Catalina fault or a submarine landslide along the nearby Palos Verdes Peninsula.

Of the four local faulting scenarios modeled in the report, the Santa Catalina Fault – Segments 1-7 Scenario represents the worst-case earthquake event. Of the two landslide scenarios modeled, the Palos Verdes Landslide II Scenario represents the worst-case landslide event. The Port Complex model predicts a maximum tsunami wave height, or reasonable worst-case scenario of approximately 2.5 to 6.0 feet above MSL for the earthquake scenario and approximately 0.6 to 13.7 feet above MSL for the landslide scenario. The highest anticipated water levels from the earthquake scenarios are predicted to occur in the East Channel and East Basin area of the Port. The highest anticipated water levels from the landslide scenarios would occur in the Outer Harbor area and the western side of Pier 400. The modeled worst-case tsunami scenario was based partially on a moment magnitude 7.6 earthquake on the offshore Santa Catalina fault. According to the Tsunami Hazard Assessment, the modeled recurrence interval for a magnitude 7.5 earthquake along an offshore fault in southern California 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 and Nichol, 2007).

3.5.2.2.4 Seiches

Seiches are seismically induced water waves that surge back and forth in an enclosed basin or in a harbor because of earthquakes. A significant wave front could cause damage to seawalls and docks and could breach sea walls at the Project site. Newly designed modern shoreline protection techniques are implemented to resist seiche damage. The 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 the impacts from a seiche. As a result, the impact discussion below refers primarily to tsunamis, as this would be the worst case of potential impacts.

3.5.2.2.5 Sea Level Rise

Models suggest that sea levels along the California coast could rise substantially over the next century as a result of climate change (for additional discussion of climate change and the role of greenhouse gases [GHGs] see Section 3.2, Air Quality, Meteorology, and Greenhouse Gases). Risks associated with rising sea levels include inundation of low lying areas along the coast, exposure of new areas to flood risk, an increase in the intensity and risk in areas already susceptible to flooding, and an increase in coastal erosion in erosion prone areas.

The State of California Sea-Level Rise Interim Guidance Document (October, 2010) prepared by the Sea Level Rise Task Force of the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), recommends using the ranges of Sea Level Rise presented in the December 2009 "Proceedings of National Academy of Sciences" publication by Vermeer and Rahmstorf (2009) as a starting place for estimating sea level projections, as shown in Table 3.5-4.[7] Until 2050, there is strong agreement among the various climate models on sea level projections. For dates after 2050, three different values for sea level rise are shown based on low, medium, and high future GHG emission scenarios. As shown in the Table 3.5-4, sea level rise is predicted to be greater with higher concentrations of GHGs.

Table 3.5-4: Sea Level Rise Projections Using 2000 as the Baseline

Year	Level of GHG Emissions	Average of Models (in inches)	Range of Models (in inches)
2030		7	5-8
2050		14	10-17
2070	Low	23	17-27
	Medium	24	18-29
	High	27	20-32
2100	Low	40	31-50
	Medium	47	37-60
	High	55	43-69

Source: CCAT, 2010

LAHD reported to the California State Lands Commission in response to a survey in 2009 that some possible flooding and wave damage would occur from a 55 inch rise in sea level (State Lands Commission, 2009). As shown in Table 3.5-4 above, a 55 inch rise in sea level could occur in 2100 under the highest GHG emissions scenario. LAHD and the Rand Corporation have initiated a study that identifies Port facilities that are vulnerable to sea level rise, analyzes various strategies for managing seal level rise, and identifies sea level rise considerations for incorporation into design guidelines. The draft study is anticipated to be released in 2012.

7 These projections do not account for catastrophic ice melting, so they may underestimate actual sea level rise.

3.5.2.2.6 Subsidence

Subsidence 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 would allow the soil grains to pack closer together. This closer grain packing results in less volume and the lowering of the ground surface.

The first occurrence of subsidence was observed in the Los Angeles-Long Beach Harbor area in 1928. Subsidence has been a historic problem in the Harbor (USACE, 1990). 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 Project site lies within the Wilmington Oil Field, but not within the active drilling area. To remedy the subsidence situation, water injection programs were initiated by the City of Long Beach in 1958. Since the initiation of water injection programs in the 1950s, subsidence has been controlled and elevations have remained stable. Current subsidence monitoring and control activities in the Wilmington Oil Field include Global Positioning System (GPS) elevation surveys and monitoring at permanent GPS stations throughout the management area to for regular monitoring that allows oil recovery while maintaining surface elevations (Koerner et al, 2002).

The general harbor area, including the area of the proposed improvements experienced maximum cumulative subsidence of approximately 1.6 feet, 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).

3.5.2.2.7 Landslides

Generally, a landslide is defined as the downward and outward movement of loosened rock or earth down a hillside or slope. Landslides can either occur very suddenly or very progressively. They are frequently accompanied by 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 more probable because water can more easily infiltrate the soils. Immediate dangers from landslides include destruction of property and possible fatalities from rocks, mud, and water sliding downhill or downstream. Other dangers include broken electrical, water, gas, or sewage lines.

Hazards due to landslides are not expected to be problematic at the Project site due to its relatively flat terrain. No known or probable bedrock landslide areas have been identified during this investigation (City of Los Angeles, 1996).

3.5.2.2.8 Expansive and Corrosive Soils

Expansive soils generally result from specific clay minerals that expand when saturated and shrink in volume when dry. Project site soils also could contain expansive soils from clay minerals and imported fill materials. Fine-grained sediments with high clay content would be most susceptible to potential expansive soil impacts. Expansive soils expand in volume when saturated and shrink when dry. Further, expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula. Clay minerals are likely to be present in the geologic units as well as the artificial fill at the Project site.

Given the historic industrial development in the area, corrosive soils also could be present in the area. Corrosive soils result from the presence of high moisture content, high electrical conductivity (the ability to pass electrical current), high acidity, and high dissolved salts. These conditions result in the flow of electrical current between the soil and metallic materials, such as tanks, pipelines, and other objects in contact with the soil. This flow of electrical current results in corrosion of the metallic objects unless they are made of, or protected by, corrosion-resistant materials.

3.5.3 Applicable Regulations

3.5.3.1 Geologic Hazards

The City of Los Angeles primarily governs the geologic resources and geotechnical hazards in the proposed Project vicinity. 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, 1996 and 2001). Local grading ordinances establish detailed procedures for excavation and earthwork required during construction/demolition activities. 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, 2011). Most local jurisdictions rely on the latest California Building Standards Code as a basis of seismic design. However, with respect to wharf construction, LAHD would apply their standards and specifications to the design of the proposed Project (and alternatives). The LAHD must comply with regulations of the Alquist-Priolo Earthquake Fault Zoning Act, which regulates development near active faults to mitigate the hazard of a surface fault rupture.

The LAHD has also developed a seismic code to provide construction standards, which are contained in the "Proceedings of the Port of Los Angeles Seismic Workshop on Seismic Engineering" (LAHD, 1990).

3.5.3.2 Mineral Resources

The enactment of the Surface Mining and Reclamation Act of 1975 was to promote conservation of the mineral resources of the state and to ensure adequate reclamation of mined lands. Among other provisions, the Act 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 significant for the purpose of mineral land classification, a mineral deposit or a group of mineral deposits 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 whether the minerals are strategic or nonstrategic, the uniqueness or rarity of the minerals and the commodity-type category (e.g., 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.

The Project site and vicinity is predominately underlain by recent alluvium and dredged fill material and has been designated by the California Department of Conservation as having a classification of MRZ-1. This designation means that there is adequate information about the area to indicate that no significant mineral deposits are present or it has been judged that little likelihood exists for their presence (POLA, 2006).

3.5.4 Impacts and Mitigation Measures

3.5.4.1 Methodology

Geologic issues were identified and assessed based on existing published reports, surface reconnaissance, and knowledge of the general geologic setting. Design-level engineering geology and geotechnical investigations, subsurface explorations, laboratory testing, and analyses were not conducted. In this document, geological impacts are evaluated in two ways: (1) impacts of the proposed Project on the local geologic environment; and (2) impacts of geological hazards on components of the proposed Project that may result in substantial damage to structures or infrastructure or expose people to substantial risk of injury.

3.5.4.2 Thresholds of Significance

The *L.A. CEQA Thresholds Guide* (City of Los Angeles, 2006) is the basis for the following significance criteria and for determining the significance of impacts associated with geology resulting from development of the proposed Project. To consider geologic hazard impacts significant, the proposed Project would cause or accelerate hazards that would result in substantial damage to structures or infrastructure or exposes people to substantial risk of injury. Since the region is geologically active, there is exposure of most projects to some risk from geologic hazards, such as earthquakes. Therefore, geologic impacts are significant only if the proposed Project would result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from the following:

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

GEO-2 Tsunamis or seiches;

GEO-3 Land subsidence/soil settlement;

GEO-4 Expansive soils;

GEO-5 Landslides, mudflows; or

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

In addition, a project would normally have a significant impact with respect to landform alteration or mineral resources if:

GEO-7 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, hillslopes, canyons, ravines, rocky outcrops, water bodies, streambeds, and wetlands.

GEO-8 It would result in the permanent loss of availability of a known mineral resource of regional, state, or local significance that would be of future value to the region and the residents of the state.

GEO-9 It would result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from sea level rise.

See Section 3.13 (Water Quality, Sediments, and Oceanography) for significance criteria related to erosion. Following is an analysis of the potential for the proposed Project to impact geologic resources:[8]

3.5.4.3 Impact Determination

Impact GEO-1: During the construction period (through 2014) and operations period (through 2042), the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from seismic activity along the Palos Verdes Fault zone or other regional faults that could produce fault ruptures, seismic ground shaking, liquefaction, or other seismically induced ground failure.

Geologic conditions exist at the proposed Project site that potentially could expose people and structures to geologic hazards. The proposed Project area is potentially susceptible to seismicity and to the following seismically induced geologic hazards: faulting, including surface rupture; liquefaction; subsidence; and tsunamis and seiches. Ground rupture could occur on faults within the Palos Verdes fault zone. All other seismically induced hazards could occur because of movement on the Palos Verdes fault zone and other regional faults.

[8] Refer to Chapter 6 – Analysis of Alternatives – for the analysis of potential impacts on geologic issues associated with the alternatives.

The Los Angeles Building Code, Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, regulates construction. These building codes and criteria provide requirements for construction, grading, excavations, use of fill and foundation work, including type of materials, design, procedures, etc. The intention of these codes is to limit the probability of occurrence and the severity of consequences from geological hazards, such as earthquakes. Necessary permits, plan checks, and inspections are required and will be complied with. The Los Angeles Municipal Code also incorporates structural seismic requirements of the UBC, which classifies almost all of coastal California (including the proposed Project site) in Seismic Zone 4, on a scale of 1 to 4, with four being most severe. The Port's and City of Los Angeles' Department of Building and Safety engineers would review the proposed Project plans to insure compliance with the appropriate standards established in the building codes. The proposed Project would comply with seismic requirements and applicable building code sections as they relate to excavation, grading, and paving. Means and methods to minimize the effects of seismic events during demolition and excavation of foundations include the proper use of shoring or sloping for excavations and proper equipment support.

The proposed Project features would not cause or accelerate geologic hazards. The proposed Project would remove several existing buildings and structures that are not built to current seismic standards and construct one new office building constructed to current seismic standards, thus reducing the risk of geologic hazards at the Project site. However, the Los Angeles region, as with the southern California region as a whole, cannot avoid earthquake-related hazards, such as liquefaction, ground rupture, ground acceleration, and ground shaking. In particular, the harbor area cannot avoid these hazards where the Palos Verdes fault zone is present, and hydraulic and alluvial fill is pervasive.

Because active faults are located near the Project area, and the area is mapped within an area of historic liquefaction, there is a potential for substantial risk of seismic impacts and subsequent potential to contribute to seismically induced ground shaking that could result in injury to people and damage to structures. However, incorporation of modern construction engineering and safety standards and compliance with current building regulations, impacts due to seismically induced ground failure would be less than significant.

3.5.4.3.1 Seismicity

The Los Angeles Basin, including the Harbor, is an area of known seismic activity. In general, design and construction in accordance with applicable laws and regulations pertaining to seismically induced hazards are required to minimize structural damage and the associated risk of injury in the event of an earthquake. Structures in California must be designed to withstand specific seismic loads, which may vary depending upon project location and soil conditions. The site is located within Seismic Zone 4, as is the case for most of Southern California.

Even though the site would be subject to seismic activity, the incorporation of modern construction engineering and safety standards and compliance with current building regulations, impacts due to seismicity would reduce proposed Project impacts to less than significant. Potential impacts related to seismicity would be less than significant.

3.5.4.3.2 Surface Rupture

The ALBS lies approximately 1,600 feet to the west of the nearest fault trace associated with the Palos Verdes fault zone (refer to Figure 3.5-1). As a result of the close proximity of the site to the fault trace, surface rupture could occur on the Project site. In general, design and construction in accordance with applicable laws and regulations pertaining to fault hazards are required to minimize structural damage and the associated risk of injury in the event of an earthquake.

Even though the site would be subject to surface rupture, the incorporation of modern construction engineering and safety standards and compliance with current building regulations, impacts due to seismicity would reduce Project impacts to less than significant. Potential impacts related to surface rupture would be less than significant.

3.5.4.3.3 Ground Shaking

The Project site is within an area identified as susceptible to ground shaking. 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 must get 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 Project site, where seismic waves move more slowly. The exposure of people to seismic ground shaking is a potential risk with or without any project undertaken in the harbor. In addition, the risk of ground shaking cannot be avoided. Building and construction design codes are meant to minimize structural damage resulting from a seismic event but cannot constitute a guarantee.

Even though the site would be subject to ground shaking, the incorporation of modern construction engineering and safety standards and compliance with current building regulations, impacts due to ground shaking would reduce the proposed Project impacts to less than significant. Potential impacts related to ground shaking would be less than significant.

3.5.4.3.4 Liquefaction

The Project site and vicinity is located within an area designated as “Susceptible to Liquefaction” by the Los Angeles General Plan, Safety Element (City of Los Angeles, 1996). The Project area may be impacted by liquefaction since it is partly constructed on existing artificial fill areas. Because the Project site would covered with an impermeable layer (i.e., concrete or asphalt paving), there would be low potential for recharge from infiltration of surface runoff. Dredge material and compaction requirements to fill CDFs would be specified in consideration of the known potential for permanent ground displacements.

Even though the site would be subject to liquefaction, the incorporation of modern construction engineering and safety standards and compliance with current building regulations, impacts due to liquefaction would reduce the proposed Project impacts to less than significant. Potential impacts related to liquefaction would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact GEO-2: Construction and operation of the proposed Project in the Port area would not expose people and structures to substantial risk involving tsunamis or seiches.

The Port Complex has historically been subject to tsunamis and seiches; therefore, placement of any development on or near the shore, including the Project site, would always involve the exposure of people to the hazards 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 LAHD as the average, or normal condition for most on and near-shore locations here in southern California. A significant impact, therefore, from a tsunami or seiche for this Project would be one that would exceed this normal condition, and cause substantial damage or substantial injuries.

According to the Safety Element of the Los Angeles City General Plan, the Project site is within an area susceptible to impacts from a tsunami and subject to possible inundation as a result. However, in the period since publication of the Safety Element, a detailed tsunami hazard assessment (Moffatt and Nichol, 2007) concluded that large earthquakes (Mw~7.5) are very infrequent and not every large earthquake is expected to generate a tsunami. In fact, only about 10 percent of large earthquakes have the potential to generate a tsunami of some size. Furthermore, based on the seismicity, geodetics, and geology, a large locally generated tsunami from either local seismic activity or a local submarine landslide would probably not occur more than once every 10,000 years. Based on this report, the chances of a tsunami are very remote.

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 man-made structures such as dikes or concrete walls. As indicated in the tsunami hazard assessment (Moffatt and Nichol, 2007), maximum water levels were produced/simulated under the Palos Verdes Landslide II scenario. This particular landslide simulation produced water levels in excess of 22.96 feet (7 meters). There is a potential for tsunami-induced flooding within the Port, under this worst-case scenario. In particular, an event similar to this scenario could produce flooding in areas located on Pier 400, Navy Mole, and Cabrillo Beach.

However, the Project site is located more than two miles from the harbor entrance in Fish Harbor, and ranges in elevation from 10.1 feet above MSL (7.3 feet MLLW) along the timber wharf to approximately 14.8 feet MSL (12 feet above MLLW) in the upland areas. Under the worst-case local faulting scenario (Santa Catalina Fault – 7 Segments Scenario), the predicted shoreline tsunami water level at the Project site (Fish Harbor) ranges from 3.9 to 5.2 feet above MSL. Under the worst-case landslide scenario (Palos Verdes Landslide II Scenario), the predicted shoreline tsunami water level at the Project site (Fish Harbor) ranges from 3.2 to 4.9 feet above MSL. Further, under the proposed Project, the pier structures and the CDFs would be constructed to an elevation of approximately 14.8 feet MSL (12 feet MLLW) to allow for the site to drain inward towards to the new BMPs and other drainage structures. This would increase the MSL at the Project site from approximately 10.1 feet MSL to 14.8 feet MSL at the CDFs. The proposed Project would result in a slight sloping of the site from the CDFs downward towards the backlands of the Project site. Therefore, under the worst-case scenarios (faulting and landslide), the maximum tsunami wave height would not likely breach the Project site. Therefore, no substantial risk of flooding from earthquake based tsunamis or seiches are likely at the Project site.

Further, since redevelopment of the waterfront and any facilities installed on the newly created CDFs would be at a higher elevation than the existing site elevation, the Project site would be even less vulnerable to inundation and flooding impact cause by tsunami or seiche. Future use of the CDF areas could include construction of structures or placement of equipment. Measures to minimize impacts from seiches or tsunamis, such as the breakwater and constructing facilities at adequate elevation, are currently in place throughout the Port. Considering the low risk of inundation or flooding, construction and operation of the proposed Project would not expose people or property to substantial risk or injuries in the event of a tsunami or seiche. Therefore, impacts related to tsunamis or seiches would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact GEO-3: Construction and operation of 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.

The proposed Project site is constructed on artificial fill areas. Subsidence in the vicinity of Project area related to previous oil extraction in the Port area has been mitigated and is not anticipated to adversely impact the proposed Project. Construction and operation of the proposed Project would not cause settlement or subsidence that could result in substantial damage to structures or infrastructure or expose people to substantial risk of injury. Therefore, potential impacts related to subsidence would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact GEO-4: Construction and operation of the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from soil expansion.

Expansive soils exist in the Project area that would require compaction according to approved engineering standards. Expansive soils beneath building foundations could result in cracking and distress of foundations, or otherwise damage structures built on these sediments. However, during the proposed Project design phase, the proposed Project engineer would evaluate the expansion potential associated with on-site soils, as a standard engineering practice. The evaluation of the soil expansion potential would be 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. Incorporated recommendations of the engineer would be in the design specifications for the proposed Project, and comply with City design guidelines, including Sections 91.000 through 91.7016 of the Los Angeles Municipal Code, in conjunction with criteria established by LAHD. Recommendations for soils subject to expansion typically include over excavation and replacement of expansive soils with sandy, non-expansive soils. Other recommendations could include installation of concrete or steel foundation piles through the expansion-prone soils, to a depth of non-expansive soils. If expansive soils are encountered during construction activities, those soils would be removed and replaced or mixed with non-expansive materials, which is a standard construction technique for addressing expansive soils. Another option would be the presaturation of potentially expansive soils. Appropriate measures would be determined by a geotechnical engineer prior to the beginning of Project construction.

As discussed above, the proposed Project would be required to implement measures recommended by the Project's geotechnical engineer, and comply with applicable standards and policies of the Los Angeles Municipal Code, and other applicable regulations that would ensure the proposed Project does not result in substantial risk to life or property. Therefore, impacts related to soil expansion would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact GEO-5: Construction and operation of the proposed Project would not result in or expose people or property to a substantial risk of landslides or mudflows.

The topography near the proposed Project site is flat and is not prone to landslides or mudflows due to the lack of slope. Although underwater landslides have been identified offshore, the Project site is located within an enclosed harbor and is not expected to result in or contribute to offshore underwater landslides. Therefore, no construction or operation impacts would occur.

Mitigation Measures

No mitigation is required.

Residual Impacts

There would be no impacts.

Impact GEO-6: Shallow groundwater, which would cause unstable collapsible soils, may be encountered during excavation, but it would not expose people or structures to substantial risk.

As part of the proposed Project, removal any existing contamination associated with the structures and beneath existing facilities (approximately 0.81 acre of pavement would be removed for off-site disposal and the area graded) would be encountered as part of the Project excavation requirements on the Project site. The proposed Project site is constructed on landfill areas. Any soil excavation would consist of artificial fill soils in a previously disturbed area, and therefore would result in less than significant impact.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

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

The proposed Project area is 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 impact to prominent geologic or topographic features is anticipated to occur.

Mitigation Measures

No mitigation is required.

Residual Impacts

There would be no impacts.

Impact GEO-8: Construction and operation of the proposed Project would not result in the permanent loss of availability of a known mineral resource of regional, statewide, or local significance.

The proposed Project is located in Fish Harbor on Terminal Island, which is made mostly of artificial fill material. No known valuable mineral resources would be impacted by the proposed Project. According to the California Department of Conservation Division of Mines and Geology mineral resource maps, the nearest mineral resources area is located in the San Gabriel Valley. According to the City of Los Angeles General Plan Safety Element and the California Department of Conservation, Division of Oil, Gas, and Geothermic Resources, the Project site is located to the south of the Wilmington Oil Field. Because the proposed Project would not be located within the oil field and because construction would be at the surface or shallow depths relative to the oil field, no impacts are anticipated.

Mitigation Measures

No mitigation is required.

Residual Impacts

There would be no impacts.

Impact GEO-9: Construction and operation of the proposed Project in the Port area would not expose people and structures to substantial risk involving sea level rise.

Pursuant to CEQA Guidelines Section 15126.2, an EIR should evaluate any potential significant impacts of locating development in areas susceptible to hazard conditions identified in authoritative hazard maps, risk assessments or in land use plans addressing such hazard areas. This analysis is required should the potential hazard be likely occur within the projected life of the project and there is some degree of certainty associated with the risk associated with a potential hazard (California Natural Resources Agency, 2009). As discussed in Section 3.5.2.2.5, there is strong agreement among climate models on sea level projections through 2050; but models diverge after 2050 depending on the level of GHG emissions assumed. Additionally, the ALBS lease renewal is for 30 years; therefore, this analysis focuses on potential sea level rise project to occur through 2050.

As previously discussed, LAHD and the RAND Corporation are currently in the process of developing a study to assess potential effects of sea level rise at the Port. While the study has not yet been finalized, initial data released in January 2011 as part of a public presentation has indicated that portions of the Port may be susceptible certain sea level rise elevation. The January 2011 presentation on the status of the LAHD and RAND Corporation study to assess sea level rise included maps showing sea level projections under three scenarios – 1 meter (39.37 inches or approximately 3 feet), 2 meters (78.74 inches or approximately 7 feet) and 3 meters (118.11 inches or approximately 10 feet). The maps indicate the following at the Project site as it currently exists (i.e., at existing elevation) for each sea level rise scenario:

- A 1 meter (39.37 inches or 3 feet) sea level rise would have limited effect on the ALBS site and access to the site;
- A 2 meters (78.74 inches or 7 feet) sea level rise would have limited direct effect on the ALBS site, but may affect access to the site (i.e., access roads may be flooded); and
- A 3 meters (118.11 inches or 10 feet) sea level rise would likely result in flooding on the ALBS site and could restrict site access due to flooding” .

Flood hazard maps prepared by researchers at the Pacific Institute suggest that sea level rise of 1.4 meters (55.11 inches or approximately 5 feet) would have some direct impact on the existing ALBS site and surroundings (Pacific Institute, 2009).

With implementation of the proposed Project, the new elevation at the top of the bulkhead would be approximately 12 feet MLLW. High tide is 7 feet MLLW, so a sea level rise of less than 5 feet (196.85 inches) would not directly impact the Project site. However, Seaside Avenue is at a lower elevation than the ALBS and Southwest Marine facilities; therefore, a sea level of less than 5 feet could impede landside access. As shown in Table 3.5-4, models predict that over the next century sea level could rise as much as approximately 6 feet (69 inches) and over the ALBS 30-year lease term (and beyond - through 2050), sea levels are predicted to rise by 1.5 feet (17 inches) or less. Therefore, the proposed Project is not expected to be significantly impacted by sea level rise.

Further, since redevelopment of the waterfront and any facilities installed on the newly created CDFs would be at a higher elevation than the existing site elevation, the Project site would be even less vulnerable to inundation or flooding caused by sea level rise. Future use of the CDF areas could include construction of structures or placement of equipment. Measures to minimize impacts from seiches or tsunamis, such as the breakwater and constructing facilities at adequate elevation, are currently in place throughout the Port, which would also serve to limit the effects of sea level rise. Further, upon completion of the sea level rise study, LAHD will begin planning for and implementing strategies to address predicted sea level rise to minimize potential future adverse affects on Port operations and access. Considering the low risk of inundation or flooding, construction and operation of the proposed Project would not expose people or property to substantial risk or injuries in the event of sea level rise and the impacts are less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

3.5.4.4 Summary of Impact Determinations

The following Table 3.5-5 summarizes the impact determinations of the proposed Project related to geology, as described in the detailed discussion in Sections 3.5.4.3. Identified potential impacts are based on federal, state, or City of Los Angeles significance criteria, Port criteria, and the scientific judgment of the report preparers, as applicable.

Table 3.5-5: Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project

Environmental Impacts	Impact Determination	Mitigation Measures	Impacts after Mitigation
GEO-1: During the construction period (through 2014) and operations period (through 2042), the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from seismic activity along the Palos Verdes Fault zone or other regional faults that could produce fault ruptures, seismic ground shaking, liquefaction, or other seismically induced ground failure.	Less than significant	No mitigation is required	Less than significant
GEO-2: Construction and operation of the proposed Project in the Port area would not expose people and structures to substantial risk involving tsunamis or seiches.	Less than significant	No mitigation is required	Less than significant
GEO-3 Construction and operation of 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.	Less than significant	No mitigation is required	Less than significant
GEO-4: Construction and operation of the proposed Project would not result in substantial damage to structures or infrastructure or expose people to substantial risk of injury from soil expansion.	Less than significant	No mitigation is required	Less than significant
GEO-5: Construction and operation of the proposed Project would not result in or expose people or property to a substantial risk of landslides or mudflows.	No Impact	No mitigation is required	No Impact
GEO-6: Shallow groundwater, which would cause unstable collapsible soils, may be encountered during excavation, but it would not expose people or structures to substantial risk.	Less than significant	No mitigation is required	Less than significant
GEO-7: Construction and operation of the proposed Project would not result in the destruction, permanent covering or the material and adverse modification of one or more distinct and prominent geologic or topographic features.	No impact	No mitigation is required	No impact

Table 3.5-5: Summary Matrix of Potential Impacts and Mitigation Measures for Geology Associated with the Proposed Project

Environmental Impacts	Impact Determination	Mitigation Measures	Impacts after Mitigation
GEO-8: Construction and operation of the proposed Project would not result in the permanent loss of availability of a known mineral resource of regional, statewide or local significance.	No impact	No mitigation is required	No impact
GEO-9: Construction and operation of the proposed Project in the Port area would not expose people and structures to substantial risk involving sea level rise.	Less than significant	No mitigation is required	Less than significant

3.5.4.5 Mitigation Monitoring

In the absence of significant impacts, mitigation measures are not required.

3.5.5 Significant Unavoidable Impacts

No significant unavoidable impacts to Geology would occur as a result of construction or operation of the proposed Project.

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