E. GEOLOGY AND SOILS

1. INTRODUCTION

This section of the EIR describes the geologic and soils conditions underlying the project site and provides an analysis of potential impacts associated with geological hazards related to seismic impacts and subsurface geologic conditions. The analysis in this section is based on information, conclusions, and recommendations contained in a *Geotechnical Investigation Report* prepared for another project proposal for this site by Converse Consultants in September 2005 and a Supplemental Geotechnical Evaluation prepared by Ninyo & Moore in October 2010 that evaluates the adequacy of the geotechnical report relative to the current proposed project and provides project-specific analysis of geology and soils impacts. These documents are included in Appendix E of this EIR.

2. ENVIRONMENTAL SETTING

a. Regulatory Framework

(1) State of California

(a) Alquist-Priolo Earthquake Fault Zones

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 established the Alquist-Priolo Earthquake Fault Zones in order to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Act (PRC Section 2621) was passed in response to the 1971 San Fernando Earthquake, which caused extensive surface fault ruptures that damaged homes, commercial buildings, and other structures. The primary purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings for human occupancy on the surface trace of active faults, to provide the citizens with increased safety, and to minimize the loss of life during and immediately following earthquakes by facilitating seismic retrofitting to strengthen buildings against ground shaking (PRC Section 2621.5).

Under the Alquist-Priolo Act, the State Geologist is required to establish regulatory zones, known as Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps to assist cities and counties in planning, zoning, and building regulation functions. Maps are distributed to all affected cities and counties for the controlling of new or renewed construction and are required to sufficiently define potential surface rupture or fault creep. The State Geologist is also required to continually review new geologic and seismic data, revise existing zones, and delineate additional earthquake fault zones when warranted by new information.

Local agencies are required to enforce the Alquist-Priolo Act in the development permit process, where applicable, and may impose greater restrictions than State law requirements. In addition, according to the Alquist-Priolo Act, prior to the approval of projects, cities and counties are required to conduct a geologic investigation of the project site by a licensed geologist, demonstrating that buildings will not be constructed across active faults. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back a minimum of 50 feet although setback distances may vary. The

Alquist-Priolo Act and its regulations are presented in California Division of Mines and Geology (CDMG, now the California Geological Survey)'s Special Publication (SP) 42.

Although Alquist-Priolo Earthquake Fault Zones have been designated on established fault systems in the Los Angeles Basin, the State has not specifically classified more recently identified active fault systems, including sections of the Hollywood Fault. However, State law allows for local jurisdictions to identify active faults and to impose appropriate building restrictions, consistent with the objectives of the Alquist-Priolo Act.

The proposed project, like all other development projects located in southern California, is subject to seismic effects, and therefore the Alquist-Priolo Earthquake Fault Zoning Act of 1972 is relevant to the proposed project.

(b) Seismic Hazards Mapping Act

The State of California Seismic Hazards Mapping Act of 1990 (PRC Section 2690-2699) addresses the effects of strong ground shaking, liquefaction, landslides, and other ground failures due to seismic events. Under this Act, the State Geologist is required to delineate "seismic hazard zones." Cities and counties are required to regulate certain development projects within the zones, investigate the geologic and soil conditions of the project, and incorporate appropriate mitigation measures, if any, into development plans. Additional regulations and policies provided by the State Mining and Geology Board assist municipalities in preparing the Safety Element of their General Plan and encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety.

Under PRC Section 2697, cities and counties shall require a geotechnical report defining and delineating any seismic hazard prior to the approval of a project located in a seismic hazard zone. Each city or county shall submit one copy of each geotechnical report, including mitigation measures, to the State Geologist within 30 days of its approval. In addition, under PRC Section 2698, cities and counties are not prohibited from establishing policies and criteria which are more stringent than those established by the Mines and Geology Board.

State publications supporting the requirements of the Seismic Hazards Mapping Act include the CDMG SP 117, "Guidelines for Evaluating and Mitigating Seismic Hazards in California" and CDMG SP 118, "Recommended Criteria for Delineating Seismic Hazard Zones in California." SP 117 objectives include the evaluation and mitigation of earthquake-related hazards for projects within designated zones of required investigations and to promote uniform and effective Statewide implementation of the evaluation and mitigation elements of the Seismic Hazards Mapping Act. SP 118 implements the requirements of the Seismic Hazards Mapping Act in the production of Probabilistic Seismic Hazard Maps for the State and also establishes criteria for the determination of landslide hazard zones and liquefaction hazard zones. Seismic evaluation and hazard maps have been prepared for the Newport-Inglewood Fault system, Palos Verdes Fault, Raymond Fault, Santa Monica Fault system, Sierra Madre Fault system (San Fernando Fault), and the Los Angeles Blind Thrust Faults, including the Compton, Elysian Park, Northridge, and Puente Hills Faults.

The proposed project, like all other development projects located in southern California, is subject to seismic effects, and therefore the Seismic Hazards Mapping Act is relevant to the proposed project.

(2) City of Long Beach

Building and construction within the City of Long Beach are subject to the regulations of the City of Long Beach Municipal Code (LBMC). Municipal Code Chapter 18.24, Building Codes, adopts and incorporates by reference the California Building Code (CBC). This Municipal Code chapter includes amendments and modifications to the California Building Code that are specific to the City of Long Beach. The California Building Code in turn incorporates provisions of the Uniform Building Code (UBC), which contains seismic design criteria and grading standards.

The City of Long Beach adopted the Seismic Safety Element of the General Plan in October 1988. The purpose of this Element is to provide a comprehensive analysis of seismic factors in order to reduce the loss of life, injuries, damage to property, and social and economic impacts resulting from future earthquakes. The Seismic Safety Element contains goals and recommendations that provide guidance for development in seismically active areas. Specifically, the Element contains goals such as: (1) reducing public exposure to seismic risks; (2) providing an urban environment which is as safe as possible from seismic risk; and (3) providing the maximum feasible level of seismic safety protection services.[1]

All development projects in the City of Long Beach are required to comply with the City's Building Codes, and therefore the proposed project is subject to the building requirements of the LBMC.

b. Existing Conditions

(1) Geologic Setting

The project site is located within the Long Beach Plain in the coastal portion of California's Peninsular Ranges geomorphic province, which extends northwesterly from Baja California into the Los Angeles Basin and westerly into the offshore area, including Santa Catalina, Santa Barbara, San Clemente, and San Nicolas islands. The northern boundary of the province is the Transverse Ranges along the Malibu, Santa Monica, Hollywood, Raymond, Sierra Madre, and Cucamonga faults. The eastern boundary of the province is the Colorado Desert geomorphic province along the San Jacinto fault system. The Peninsular Range is characterized by northwest/southeast trending alignments of mountains and hills and intervening basins, reflecting the influence of northwest trending major faults and folds that control the general geologic structural fabric of the region. The closest fault zone is the Newport-Inglewood (L.A. Basin) fault zone, a northwest-trending structural zone expressed at the surface by a series of discontinuous low hills, located approximately 1,000 feet to the northeast of the project site, and the Palos Verdes fault located 7.7 miles to the southwest of the project site.

(2) Subsurface Conditions

The project site is underlain by fill material ranging from 0.5 to 2.5 feet below the existing ground surface (bgs). In addition, oil was encountered in three of the borings within 5 to 10 feet bgs. Thicker fill is located under the existing buildings and within other areas of the project site. The fill materials were likely associated with construction of the existing buildings and mainly consist of silty sand and sandy silt. Alluvial

[1] *City of Long Beach, Seismic Safety Element, City of Long Beach General Plan, October 1988.*

deposits underlie the fill material to the maximum explored depth of 81.5 feet bgs. The alluvial deposits within the project site generally consist of silty sand, sandy silt, silt, clay, clayey sand, and sand with silt.

(3) Groundwater

Groundwater was encountered within all borings at depths ranging from 10 to 15 feet bgs. Based on historical data, the water level at the area around the project site ranges from approximately 6.5 to 10 feet bgs. It should be noted that groundwater monitoring wells were installed as part of a clean up on the adjacent Unocal gas service station, which indicated groundwater at a depth of 6.5 feet to 12 feet bgs. In addition, the quarterly monitoring report indicates the depth to groundwater ranges from 7.39 feet to 9.16 feet bgs. Finally, due to the proximity of the project site to the coastal zone, the depth to groundwater beneath the project site is expected to be influenced by tidal fluctuations. Also, fluctuations in the groundwater level could occur due to changes in seasons, variations in rainfall, irrigation, regional groundwater pumping, and other factors.

(4) Faulting and Seismicity

(a) Faulting

The project site is located within the seismically active region of southern California. Earthquakes generated from nearby or distant fault zones will result in ground shaking throughout the region. The California Building Code (CBC) recommends that the design of structures be based on the horizontal peak ground acceleration (PGA) having a 2 percent probability of exceedance in 50 years, which is defined as the Maximum Considered Earthquake (MCE). The statistical return period for PGA_{MCE} is approximately 2,475 years. Earthquake acceleration is measured in the common value "g", with 1.00g being equal to the acceleration of gravity at the earth's surface (9.8 meters per second per second [m/sec/sec]). The probabilistic PGA_{MCE} for the site was calculated as 0.68g using the United States Geological Survey (USGS)'s web-based ground motion calculator. The design PGA was estimated to be 0.45g using the USGS ground motion calculator.

There are numerous active, potentially active, and inactive faults located throughout the southern California region. Based on criteria developed by the California Geological Survey (formerly the California Division of Mines and Geology) faults are categorized as active, potentially active, or inactive. Active faults are those that show evidence of surface displacement within the last 11,000 years. Potentially active faults are those that have demonstrated surface displacement within the last 1.6 million years while inactive faults have not moved in the last 1.6 million years. A list of faults in the region and associated fault parameters are included in **Table IV**.E-1**,** *Characteristics and Estimated Maximum Earthquakes for Faults Considered for the City of Long Beach***,** and the locations of fault zones are illustrated in **Figure IV.E-1**, *Regional Fault Map*. The following describes the two major known faults in the project area.[2]

Newport-Inglewood Fault Zone. The Newport-Inglewood Fault Zone, which is located approximately 1,000 feet northeast of the project site at its closest point, is a right-lateral wrench fault system consisting of a series of fault segments and folds. This zone is visible on the surface as a series of northwest trending elongated hills extending from Newport Beach to Beverly Hills, including Signal and Dominquez Hills.

[2] *City of Long Beach, Seismic Safety Element, City of Long Beach General Plan, October 1988.*

Table IV.E-1

Characteristics and Estimated Maximum Earthquakes for Faults Considered for the City of Long Beach

Fault Name	Fault Classification	Approximate Distance from City Miles (km)	Approximate Fault Length Miles (km)	Estimated Slip Rate mm/yr	Estimated Maximum Earthquake
Newport-Inglewood Fault Zone	Right Lateral	0-3 (0-5)	44 (70)	0.5	7.0
Palos Verdes	Right Lateral-Reverse	4.5 (7)	50 (80)	0.8	7.0
Santa Monica-Malibu Coast Fault Zone					
Santa Monica	Reverse Left Lateral	23 (38)	35 (56)	0.4	7.0
Hollywood	Reverse Left Lateral	24 (39)	11 (18)	0.4	7.0
Malibu Coast	Reverse Left Lateral	26 (42)	34 (54)	0.1	7.0
Anacapa-Dume	Reverse Left Lateral	28 (45)	50 (80)	0.4	7.0
Raymond	Reverse Left Lateral	24 (39)	14 (22)	0.2	6.8
Verdugo	Reverse Right Lateral	25 (40)	19 (30)	0.1	6.8
Sierra Madre Fault System					
Sierra Madre Segment	Reverse Left Lateral	28 (46)	11 (18)	2	7.0
Duarte Segment	Reverse Left Lateral	29 (47)	10 (16)	3	7.0
Dunsmore Segment	Reverse Left Lateral	31 (50)	9 (15)	3	7.0
San Andreas (South Central)	Right Lateral	50 (80)	196 (314)	36	8.5
San Jacinto	Right Lateral	50 (80)	160 (256)	8	7.5
Elsinore	Right Lateral	27 (43)	137 (219)	4	7.3
Whittier	Right Lateral-Reverse	19 (30)	28 (45)	1.2	7.0
Elyslan Park-Montebello Zone of Deformation	Reverse	19 (30)	13 (20)	0.4	6.5
Catalina Escarpment	Right Lateral	37 (60)	60 (96)	0.8	7.0
San Pedro Basin	Right Lateral	20 (32)	28 (45)	0.5	7.0
San Clemente Escarpment	Right Lateral	48 (77)	150 (240)	0.8	7.0

Source: City of Long Beach, General Plan Seismic Safety Element, 1988

Topographic highs along the zone are surface expressions of individual faulted anticlinal structures, and these faults and folds act as groundwater barriers and, at greater depths, form petroleum traps.

Detailed studies along the fault zone show it to exhibit right lateral displacement of up to 6,000 feet since mid-Pliocene time, with a maximum displacement of up to 10,000 feet since late Miocene time. Vertical displacement has also occurred along the zone and appears to be primarily due to the associated folding.

The average long term horizontal slip rates appear to have been a relatively consistent 0.5 millimeters per year. An estimated maximum earthquake of magnitude 7.0 has been assigned to the zone on the basis of its estimated rupture length and its slip rate. Active or potentially active faults of the Newport-Inglewood Fault Zone within the boundaries of Long Beach include the Cherry Hill Fault, the Northeast Flank Fault, and the Reservoir Hill Fault. A possible fault may exist in the area of Marine Stadium. A topographic scarp suggestive of faulting exists along the western end of Marine Stadium, roughly paralleling the old Pacific Electric right-of-way.

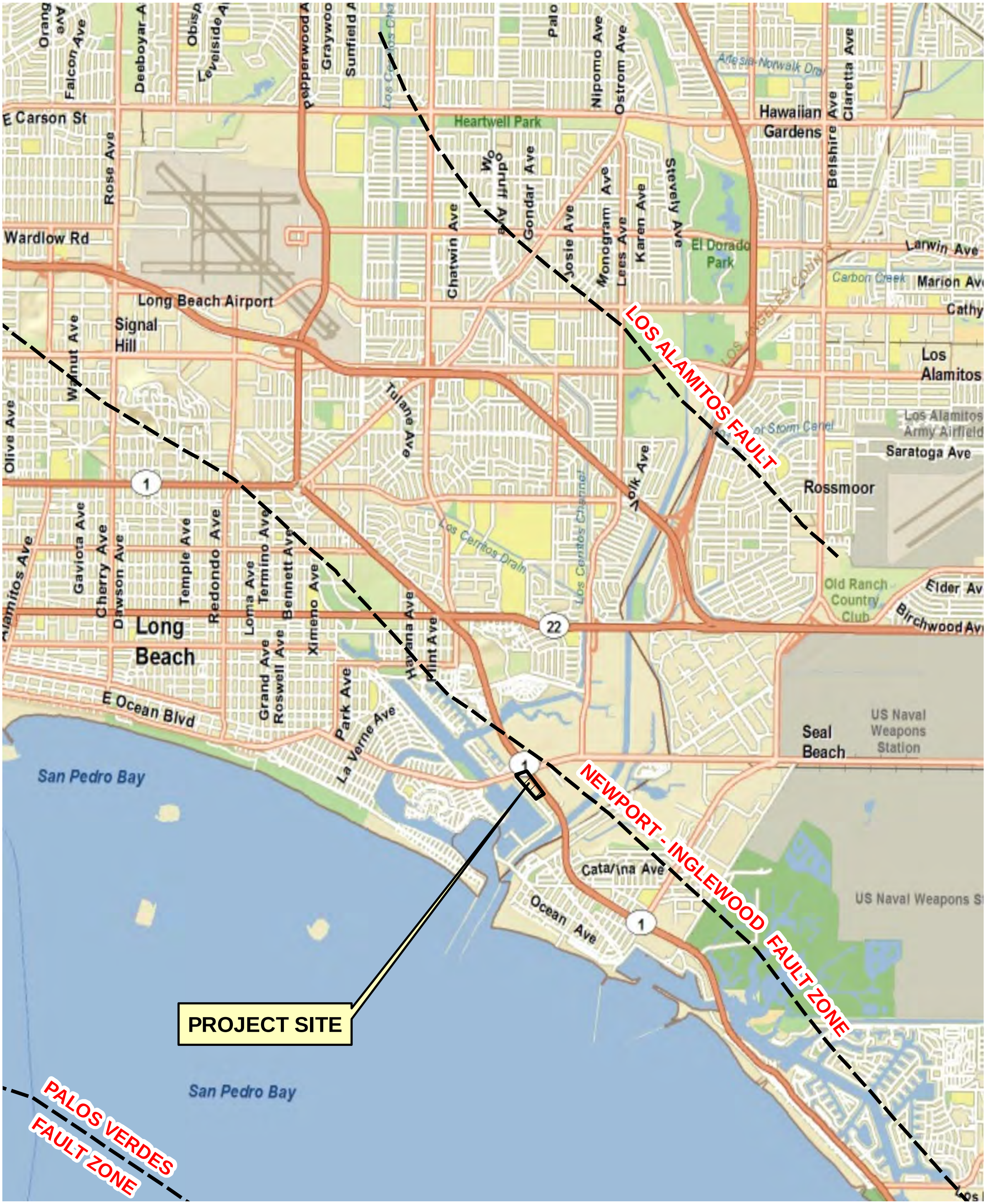
Subsurface movement on the Newport-Inglewood Zone produced the 1933 Long Beach (magnitude 6.3) Earthquake that caused severe damage in the City of Long Beach; and the 1920 Inglewood Earthquake (estimated magnitude 4.9) , that resulted in notable damage in the City of Inglewood. Ground breakage has not been observed along the faults of the Newport-Inglewood Zone in historic times within the City of Long Beach. However, the existence of the well defined fault scarps is suggestive of ground breakage in recent geologic time (i.e., within the last 10,000 years).

Since enactment of the Alquist-Priolo studies Zones Act in 1972, about 70 geologic reports have been prepared covering properties within the zones in the City of Long Beach. The purpose of these reports was to investigate for possible faults, and if found, determine whether or not the fault represented a potential surface rupture hazard to structures. Several branches of the Newport-Inglewood Fault Zone have been examined by subsurface trenching and have showed evidence of recent (Holocene) displacement. Other fault traces that have been investigated were reported by various authors to not cut sediments of Holocene age or older. The City of Long Beach has an active program of reviewing the Special Studies Zones geologic reports.

Palos Verdes Fault Zone. The Palos Verdes Fault lies immediately offshore of the City of Long Beach and is one of several major northwest trending faults in southern California that are tectonically associated with the northwest trending San Andreas Fault System. Most of the mapped length of the Palos Verdes Fault is offshore of southern California extending northwestward from Lasuen Knoll into San Pedro Bay, through Los Angeles Harbor, across the northern front of the Palos Verdes Hills, and into Santa Monica Bay. In Santa Monica Bay, the fault appears to bend to the west down Redondo Canyon.

The onshore segment of the Palos Verdes Fault has apparently uplifted Palos Verdes Hills over 1,350 feet (410 meters) since the middle Pleistocene. Extensive deformation and folding of late Pleistocene and Holocene age sediments onshore, along the northern edge of the Palos Verdes Hills, would also indicate that compression across the Palos Verdes Fault has been active in the Holocene.

Several marine geophysical surveys have been run in Los Angeles Harbor and offshore of Long Beach. These surveys have found evidence of warping in Holocene sediments near San Pedro and evidence of faulting of the sea floor southward along the Palos Verdes Fault trace. The Palos Verdes Fault is in the same tectonic environment and is nearly parallel in orientation to other active faults, such as the Newport-Inglewood, Elsinore, and San Andreas fault zones. An estimated maximum earthquake of magnitude 7.0 has been



0 1 2 Miles

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Regional Fault Map

Second+PCH Development

Source: State of California Department of Conservation, 2010; ESRI, 2009; PCR Services Corporation, 2010.

FIGURE

IV.E-1

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assigned to this fault based on comparisons with the Newport-Inglewood Fault Zone. Other fault and earthquake parameters estimated for the Palos Verdes Fault are presented in Table IV.E-1, above.

(b) Seismicity

Based upon calculations utilizing the random mean with one standard deviation attenuation relationship and a 10 percent probability of exceedance in 50 years, a site-specific ground acceleration of 0.49 g was obtained (refer to Appendix E of this Draft EIR). The vertical acceleration may be taken equal to two-thirds of the horizontal acceleration.

(5) Other Seismic Conditions

Besides generating damaging ground motion, a nearby seismic event may impact a project by inducing landslides, earthquake-induced flooding, tsunamis, seiches, and differential settlement and ground lurching. Refer to **Table IV.E-2,** *Potential for Secondary Effects of Seismic Activity* for the potential secondary effect of seismic activity on the project site.

Table IV.E-2

Potential for Secondary Effects of Seismic Activity

Secondary Seismic Hazard	Potential Risk
Landslides	None
Tsunamis	Low
Seiches	Low
Earthquake-Induced Flooding	Low
Surface Fault Rupture	Moderate
Liquefaction	High
Differential Settlement	Moderate

Source: Converse Consultants, Geotechnical Investigative Report, September 1, 2005.

(a) Liquefaction and Seismic Settlement

Liquefaction is a phenomenon in which the structure of saturated soil collapses during strong ground shaking of considerable duration, causing water pressure in the soil to rise sufficiently to make the soil behave like a fluid for a short period of time. As a result, the soil temporarily loses considerable strength and capacity. Liquefaction generally occurs when three conditions exist: shallow groundwater; low density, fine, clean sandy soils; and high density ground motion. The effects of liquefaction on level ground include settlement and bearing capacity failures below structural foundations.

The City's General Plan Seismic Safety Element indicates that the entire project site is located within a designated liquefaction hazard zone. Liquefaction analysis was conducted for both the project site condition below the ground surface before the excavation and the project site soil below the two-story subterranean garage floor after removal 25 feet over excavation. Results of the analysis indicate that during the maximum probable earthquake (10 percent chance of occurrence in 50 years) liquefaction will occur on the project site between the depths of 10 and 40 feet bgs. Therefore, it is anticipated that the liquefaction would be general in nature and occur over the entire project site.

Research has indicated that, due to the depth at which the liquefaction is expected to occur, there may be surface expression of the liquefaction in the form of sand boils and that settlement would occur over a large area. As a result, the anticipated settlement of individual structures would be predominantly total settlement with moderate amount of differential settlement. Before excavation, the total seismically induced settlement ranges from 6.5 inches to 8.3 inches and the differential settlement is considered to be half of the total settlement. Considering 25 feet over excavation, the total seismically induced settlement ranges from 2.6 inches to 5.7 inches and the differential settlement can be assumed to be half of the total settlement.

(b) Seiche and Tsunami

A seiche is the oscillation of a body of water in an enclosed or semi-enclosed basin, such as a reservoir, storage tank, or lake, in response to earthquake activity. The project site is located in proximity to, and upgradient from, the Long Beach Harbor and associated water bodies near the mouth of the Los Angeles River. Despite the potential for limited seiche effects to occur in these water bodies during a large seismic event, it is not expected that the project site would experience flooding in that event given the elevation of the site relative to the harbor and distance to the affected water bodies.

A tsunami is a series of waves of extremely long wavelength (distance between two successional waves) and long period (time between two successional waves). A tsunami can be generated by any disturbance that displaces a large water mass from its equilibrium position and can be associated with earthquakes, landslides, volcanic eruptions, and nuclear explosions. Tsunamis are typically caused by large shallow earthquakes when tectonic displacement of the sea floor occurs and the overlying water is displaced from its equilibrium position. The project site is located along the coastline of the Pacific Ocean and therefore could experience tsunami effects; however, this risk is similar to many coastal areas along the west coast, and early warning systems and evacuation plans have been developed to minimize hazards from tsunamis. Furthermore, the presence of the harbor breakwater and intervening urban development would limit potential effects at this location.

(c) Seismically Induced Flooding

Seismically induced flooding occurs when water retention structures or facilities (such as dams or above-ground detention facilities) fail, allowing water to flow downstream unabated at higher-than-normal volumes. Although the County of Los Angeles General Plan Safety Element and the City of Long Beach General Plan Seismic Safety Element indicate that the project site is situated in an area that may be subject to flooding from a failure of the Whittier Narrows Dam or the Prado Dam, it is not anticipated that substantial flooding would occur at the project site such that significant damage would result to on-site structures. This expectation is based on the project site's distance from these dams and the relatively limited water volumes normally contained in the reservoirs.

(d) Landslides

Seismically induced landslides and slope failures are common occurrences during or soon after large earthquakes. The project site is located on relatively flat terrain. The potential for seismically induced landslides affecting the project site is considered to be very low.

(e) Surface Fault Rupture

The project site is not located within a currently designated State of California Earthquake Fault Zone. Based on a review of the existing geologic information, no major surface fault crosses through or extends towards the project site. However, the onshore portion of the Newport-Inglewood fault is located approximately 1,000 feet to the northeast of the project site and therefore, the potential for surface rupture resulting from the movement of nearby major faults in the project area is considered moderate. However, despite the moderate potential for surface fault rupture along the Newport-Inglewood fault, no surface expression of fault displacement would occur on the project site, since the fault does not cross or extend toward the site. As such, the potential for on-site surface fault rupture is considered remote. However, as previously indicated, substantial ground shaking would be anticipated to occur on-site during a seismic event along this fault system.

(f) Differential Settlement and Ground Lurching

Due to the liquefiable nature of on-site soils, the potential for significant differential settlement and ground lurching during earthquakes is considered to be moderate at the project site.

3. ENVIRONMENTAL IMPACTS

a. Methodology

Project impacts are determined based on potential risks associated with seismic activity and soil conditions, which are site- and project-specific. Impacts are determined based on the proposed project's ability to protect people and structures from geologic risks in light of existing physical conditions in the project area. Compliance with applicable seismic safety and building codes generally preclude the potential for adverse impacts; however, where applicable, recommended mitigation measures are provided to address project-related impacts. As indicated in the Initial Study prepared for the proposed project, impacts related to surface fault rupture, landslides, expansive soils, and soil suitability for septic systems were determined to be less than significant and therefore are not analyzed in this section.

b. Thresholds of Significance

A project may have a significant impact on geology and soils if it would exceed the significance thresholds included in Section VI, Geology and Soils, in Appendix G of the CEQA *Guidelines*. As such, the proposed project would result in a significant impact to geology and soils if it would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

    a. Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.

    b. Strong seismic ground shaking.

    c. Seismic-related ground failure, including liquefaction.

    d. Landslides.

2. Result in substantial soil erosion or the loss of topsoil.

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

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

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

All of these significance thresholds were preliminarily evaluated in the proposed project's Initial Study, which is included as Appendix A of this EIR. The Initial Study determined that the proposed project would have no impact or a less than significant impact with respect to threshold Nos. 1(a), 1(d), 4, and 5 and therefore no further study of that threshold was required in the EIR. Below, the remaining thresholds (i.e., Nos. 1(b), 1(c), 2, and 3) are used to further analyze the severity of the proposed project's potential impacts.

c. Project Design Features

To reduce potential impacts to geology and soils, the following project design feature would be implemented as part of the proposed project:

- To address structural concerns associated with liquefaction, seismicity, and other geologic constraints, the proposed project would comply with applicable building codes, including the UBC, CBC, and Title 18, *Buildings and Construction*, of the LBMC.
- A Stormwater Pollution Prevention Plan (SWPPP), including erosion controls, sediment controls, tracking controls, non-storm water management, materials and waste management, and good housekeeping practices, would be required for implementation during construction activities to prevent the introduction of pollutants, including soil materials, into stormwater flows off-site.
- An operational Water Quality Management Plan (WQMP) would be required for implementation to address pollutants following construction activities.

d. Analysis of Project Impacts

The project site is located within the seismically active region of southern California and would be subject to ground motion from occasional earthquakes. As stated above, the project could be susceptible to seismic disturbances and secondary effects caused by a rupture of a nearby earthquake fault and associated strong seismic ground shaking.

(1) Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic groundshaking?

As previously described, the project site is located within the seismically-active southern California region. In addition, the Newport-Inglewood fault zone is located approximately 1,000 feet to the northeast of the project site and the Palos Verdes fault is located approximately 7.7 miles southwest of the project site. As a result, the project site could experience a maximum expected site-specific horizontal ground acceleration of 0.49g with a vertical acceleration equal to two-thirds of the horizontal acceleration.

Despite the fact that the project site would experience groundshaking as a result of an earthquake along any of the active or potentially active faults in the region, as is the case in all of southern California, the proposed structures would be required to be designed, engineered, and constructed to meet all applicable local and State seismic safety requirements, including the UBC, CBC, and the LBMC. During the detailed design phase of the project, CBC seismic design factors would be developed for use by the project structural engineer in accordance with current CBC design criteria. Given compliance with current CBC design criteria, which is required by State law, as well as other applicable seismic safety requirements, impacts on the proposed development from seismic groundshaking would be less than significant.

(2) Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction?

As illustrated in Table IV.E-2, the project site has a high susceptibility to liquefaction and a moderate susceptibility to ground shaking and differential settlement. Compliance with applicable building codes, including the UBC, CBC, and Title 18, *Buildings and Construction*, of the City of Long Beach Municipal Code, would generally address the potential for adverse structural impacts from liquefaction or other ground failure. Given the site soil and groundwater conditions, as well as the specific design requirements necessary to adequately address liquefaction and ground failure, impacts in this regard would still be considered potentially significant.

Loose alluvial soils or undocumented/poorly compacted fill may be present in some areas at the project site. Compressible natural soils and undocumented fills pose the risk of adverse settlement under static loads imposed by new foundations and structures. Differential settlement of soils can cause damage to foundations, buildings and other project improvements. Site soils are not susceptible to hydro-collapse settlement. However, given the potential for ground settlement, impacts are considered potentially significant.

Overall, the proposed project would expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction. However, Mitigation Measure E-1 is provided below to address these impacts.

(3) Would the project result in substantial soil erosion or the loss of topsoil?

Soil erosion is most prevalent in unconsolidated alluvium and surficial soils, which are prone to downcutting, sheetflow, and slumping and bank failure during and after heavy rainstorms. To meet the requirements of the National Pollutant Discharge Elimination System (NPDES) General Construction Permit, the proposed project would be required to implement a SWPPP during construction activities to prevent the introduction of pollutants, including soil materials, into stormwater flows off-site. Per City requirements, the proposed project would implement a project-specific Stormwater Pollution Prevention Plan to prevent substantial erosion and/or sedimentation during storm events during construction. Additionally, to meet the water quality requirements of the County's Standard Urban Stormwater Mitigation Plan (SUSMP), under the NPDES Municipal Separate Storm Sewer System (MS4) Permit, the proposed project would also be required to prepare and implement an operational WQMP to address pollutants following construction activities. Implementation of the approved Water Quality Management Plan would minimize impacts related to erosion and other water quality impacts during project operation. Refer to Section IV.G, *Hydrology and Water Quality*, for a more detailed discussion of impacts related to erosion and water quality. Additionally, given that the project site is essentially flat and does not possess site conditions conducive to erosion, the potential for substantial soil erosion or loss of topsoil during operations is negligible. Thus, impacts are concluded to be less than significant in this regard.

(4) Would the project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

As evaluated in the proposed project's Initial Study, which is included as Appendix A of this EIR, the project site is not identified as an area of slope instability in the General Plan Seismic Safety Element. Additionally, the project site is characterized by relatively flat topography and is entirely developed, which reduces direct exposure to water. The surrounding area is characterized by a gently sloping topography that is also almost entirely developed with paved surfaces. As steep hillsides are not present on-site or in the project vicinity, impacts associated with landslides were determined to be less than significant.

Subsidence is characterized as a sinking of the ground surface relative to surrounding areas, and can generally occur where deep soil deposits are present. Subsidence in areas of deep soil deposits is typically associated with regional groundwater withdrawal or other fluid withdrawal from the ground such as oil and natural gas. The Seismic Safety Element of the City's General Plan indicates that the project site is not located within an area susceptible to subsidence.[3] However, while not likely, limited localized soil settlement or subsidence could result from temporary construction dewatering or long-term operation of the project.

A review of published references indicates that the depth to groundwater at the site has been observed as shallow as 6.5 feet. Excavations on the order of 10 feet deep are anticipated for the planned below-grade parking garage, and construction dewatering would be involved to maintain the excavations in a relatively dry condition. Lowering the groundwater in the area results in an increase in the effective stress of soil above the groundwater and, in some cases, can result in soil subsidence. Soil subsidence would be greatest at the location of the dewatering system, but would decrease away from the excavations. Nonetheless, potential impacts of localized subsidence associated with construction-related dewatering would be considered potentially significant; however, Mitigation Measures E-2 and E-3 are provided below to address this impact.

Additionally, construction of the project may involve the installation of driven piles or vibro-displacement stone columns for liquefaction mitigation. In addition, installation of shoring systems, such as sheet piles for the below grade parking structure, are also proposed. These activities during construction of the project would result in construction-related vibration that could result in ground subsidence. Based on typical construction-induced vibration distances,[4] structures located within approximately 50 to 100 feet of the project could be significantly impacted by vibration-related ground subsidence. Based on a review of site conditions and project design plans, an existing commercial building is located approximately 50 feet from the southeast side of the project site. Given the proximity of this structure to construction activities that may cause vibration, vibration-induced ground subsidence with the potential for structural damage is considered

[3] *City of Long Beach Department of Planning and Building.* Long Beach General Plan Seismic Safety Element. *Plate 5: Ground Subsidence Maps. October 1988.*

[4] *California Department of Transportation (CalTrans), 2004, Transportation- and Construction-Induced Vibration Guidance Manual, Noise, Vibration, and Hazardous Waste Management Office, dated June.*

a potentially significant impact, though Mitigation Measure E-4 is provided below to address this impact. Other off-site structures are not located within 100 feet of the site, therefore, vibration-induced ground subsidence would not have a significant impact on other structures. For an evaluation of construction-related vibration effects that are not focused on ground subsidence, see Section I, *Noise*, of this EIR.

Additionally, regarding long-term operation of the proposed project, because significant quantities of water or oil are not being extracted beneath or in close proximity to the project site, subsidence is not anticipated to pose a significant hazard to the proposed project, barring any substantial extractions in the future. Although ongoing groundwater extraction (dewatering) may be required for the proposed subterranean parking structure, such dewatering would not result in the extraction of substantial quantities of water such that subsidence could occur. Furthermore, as indicated above, the proposed project would be constructed using driven piles or other appropriate foundation system for shoring and foundation support, which would preclude the potential for ground subsidence resulting from groundwater extraction. Furthermore, the proposed dewatering would be subject to issuance of a dewatering permit from the Los Angeles Regional Water Quality Control Board. Adherence to the requirements of the dewatering permit would ensure that groundwater extraction on-site would not result in adverse impacts related to lowering of the groundwater table in the project vicinity such that notable subsidence could occur. Therefore, operational impacts related to subsidence would be less than significant.

As discussed above, the project site is located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on or off-site landslide, lateral spreading, subsidence, liquefaction or collapse. Specifically, the project site has a high susceptibility to liquefaction and a moderate susceptibility to ground shaking and differential settlement (e.g., horizontal and vertical movements from lateral spreading of liquefied materials), and therefore this impact is considered potentially significant. Nonetheless, the geotechnical reports provided in Appendix E of this EIR provide site- and project-specific recommendations to address liquefaction and/or collapse, which are included as mitigation below.

4. MITIGATION MEASURES

Compliance with applicable regulations, including state and local building and seismic safety codes, would generally reduce potential geology and soils-related risks to an acceptable level. Additionally, the proposed project would be required to prepare a project-specific geotechnical report that would include design specifications and would be subject to review and approval by the City. However, the following project-specific recommendations would serve to reduce potential impacts to less than significant:

Mitigation Measure E-1: Liquefaction and Seismic-Related Ground Failure. Proposed building foundations shall be constructed utilizing driven pre-cast piles or cast-in-place pile foundations that extend through the liquefiable zones into competent material, or an equivalent foundation system, for shoring and structural support in order to reduce the potential for adverse impacts related to liquefaction, differential settlement, ground lurching, and dewatering-related ground settlement. Alternatively, densification of the liquefiable soils using vibro-displacement stone columns or compaction grouting would mitigate the liquefaction hazard, and the new structures could then be supported on shallow foundation systems. The specific building foundation method(s) to be employed shall be determined by the project geotechnical engineer, and reviewed and approved by the City Engineer prior to issuance of building permits.

Mitigation Measure E-2: Ground Settlement. If determined necessary by the project geotechnical engineer, removal and recompaction of compressible soils or in-situ ground modification shall be utilized, based on detailed design stage recommendations, in order to address potential ground settlement.

Mitigation Measure E-3: Ground Settlement. In order to address potential ground settlement during construction activities, the construction contractor shall limit the depth of construction dewatering, install sheet piles, and pump from within the excavation to reduce the impacts to groundwater levels outside the excavation, install monitoring wells to evaluate groundwater, monitor adjacent areas for indications of settlement, and/or protect to settlement-sensitive structures through ground improvement or foundation underpinning, as deemed appropriate by the project geotechnical engineer.

Mitigation Measure E-4: Construction-Related Vibration. Depending upon the specific technique to be employed to mitigate liquefaction hazards, and prior to initiation of construction, a Vibration Management Plan (VMP) shall be prepared by a qualified consultant hired by the applicant for review and approval by the City. The VMP shall address the potential for specifically proposed construction activities to cause vibration induced ground settlement on off-site properties. The performance standard for vibration management shall be to prevent vibration induced ground settlement on nearby properties that would result in structural damage or damage to other sensitive off-site improvements. More specifically, the performance standard shall ensure that construction of the project would not result in off-site ground settlement greater than ½-inch in non-building areas or greater than ¼-inch building areas. If it is determined that there would be no potential for significant settlement on off-site properties due to proposed construction techniques, no further requirements for mitigation would apply. In the event potential for significant settlement is identified, the VMP shall include mitigation requirements that will ensure that the performance standard to prevent significant off-site ground settlement is met. Mitigation techniques to reduce the impacts of vibration may include avoiding construction activities that involve vibration, limiting construction involving vibration to specified distances from off-site sensitive receptors, monitoring vibration and settlement during construction, and/or protecting sensitive improvements from excessive settlement by ground stabilization or foundation underpinning. Monitoring methods include installation of ground survey points around the outside of excavations to monitor settlement and/or placing monitoring points on nearby structures or surfaces to monitor performance of the structures. If monitored movement shows potential for the performance standard to be exceeded during the course of construction, all work potentially associated with vibration induced settlement shall stop and the City shall be immediately informed. Subsequently, the contractor's methods shall be reviewed and changes made, as appropriate, with alternative methods of settlement reduction identified for implementation by the contractor to the satisfaction of the City.

5. CUMULATIVE IMPACTS

The proposed project would not result in significant unavoidable impacts related to geology, soils, or seismicity, with implementation of applicable mitigation measures. Furthermore, geology, soils, or seismicity impacts are site-specific and each development site is subject to, at minimum, uniform site development and construction standards relative to seismic and other geologic conditions that are prevalent within the locality and/or region. Because the development of each related project site would have to be consistent with City of Long Beach design and construction requirements and the California Building Code, as each pertains to protection against known geologic hazards, and given the known geologic conditions, impacts of cumulative development would be less than significant, and the proposed project's contribution to cumulative effects would not be considerable.

6. LEVEL OF SIGNIFICANCE AFTER MITIGATION

Impacts related to seismic ground shaking, long-term subsidence effects, soil erosion/loss of topsoil, and secondary construction-related effects other than vibration would be less than significant and do not require mitigation. Impacts related to liquefaction and seismic-related ground failure would be reduced to less than significant with implementation of Mitigation Measure E-1, which requires the use of piles or other appropriate foundation design to prevent adverse effects to on-site structures. Construction-related localized subsidence and/or ground settlement impacts would be addressed by Mitigation Measures E2 through E-4, which require soil compaction, limitation of dewatering activities, and a Vibration Management Plan to avoid potential ground settlement effects on nearby structures due to construction-related vibration. With implementation of applicable mitigation measures, impacts would be less than significant.