Section 3.5
Geology and Soils

SECTION SUMMARY

This section presents the geologic conditions for the project site and surrounding area and analyzes potential geologic hazards including whether the proposed project would: (1) expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death involving 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, strong seismic ground shaking, or seismic-related ground failure, including liquefaction; (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 an on-site or off-site lateral spreading, subsidence, liquefaction, or collapse; and, (4) be located on expansive soil, as defined in the California Building Code, creating substantial risks to life or property. A brief description of these hazards, and others, and the potential for their occurrences on-site are discussed in the subsequent sections. An analysis of potential impacts on geology and soils associated with the alternatives is detailed in Chapter 4 Analysis of Alternatives.

Section 3.5 Geology and Soils provides the following:

- A description of existing geological setting in the project site and surrounding area;
- A description of geological processes;
- A discussion on the methodology and thresholds used to determine whether the proposed project would result in a significant impact to geological resources or whether the impacts of geological hazards on components of the proposed project exists;
- An impact analysis of the proposed project associated with geological resources and soils;
- A description of any Conditions of Approval that the City would impose, or mitigation measures proposed to reduce any potential impacts and residual impacts (i.e., impacts remaining after mitigation), if applicable;
- An analysis of potential cumulative impacts associated with geology and soils;
- A summary of geology and soil impact determinations associated with the proposed project, cumulative growth, and mitigation measures; and
- A description of significant unavoidable impacts associated with geology and soils, if any.

Key Points of Section 3.5:

Although the proposed project does not have the potential to accelerate geologic hazards, it 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 State of California Earthquake Fault Zone. However, the location of the project site is within Southern California, which is an area of known seismic activity. With the exception of the International Boardwalk, the project site is located within a liquefaction hazard zone due to the combination of shallow...
groundwater and geologically recent deposits. In addition, given the presence of artificial fill, expansive soils may also be present in the project site and surrounding area.

With implementation of applicable building codes, regulations and current applicable engineering and safety standards, construction and operation of the proposed project would not expose people and buildings/structures to potential substantial adverse effects, including the risk of loss, injury, or death, related to surface rupture, ground shaking, and liquefaction. Further, design and construction in accordance with applicable laws and regulations and current applicable engineering and safety standards would minimize risks associated with the presence of expansive soil, corrosive soil, or unstable soil. Conditions of Approval that the City would impose (for approval of the proposed Conditional Use Permit) would require implementation of these codes, regulations and standards. The Conditions of Approval would be applied to the implementation of the project through the project plans and the building permit process. The City is proposing the following Conditions of Approval as part of its Conditional Use Permit procedures:

**COA GEO-1: Geotechnical Report Per the Seismic Hazard Mapping Act.**

As required by the Seismic Hazard Mapping Act of 1990 (Public Resources Code Section 2697[a]), the City shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard. Because a majority of the proposed project is within a liquefaction zone, a geotechnical report or reports prepared in accordance with the Act would be prepared and submitted to the City’s Building and Safety Division prior to implementation of the project.

**COA GEO-2: Seismic Design and Engineering Criteria.**

The proposed project would be designed and constructed in accordance with California Building Code provisions associated with seismic design and engineering criteria (including recommendations in geotechnical reports prepared as part of the design process) to minimize potential risks to people and buildings/structures in the event of seismically-induced geological hazards (including liquefaction). This includes requirements for construction, grading, excavations, use of fill, and foundation work (including type of foundation and/or soil improvement requirements), including type of materials, design, procedures, etc. Such design and construction practices would include, but not be limited to, completion of site-specific geotechnical investigations regarding construction and foundation engineering. The design would incorporate measures pertaining to temporary construction conditions as well as long-term operational conditions specific to the project site.

**COA GEO-3: Final Geotechnical Report Review and Approval.**

The final geotechnical report(s) shall be reviewed by the City’s Building and Safety Division for findings and recommendations, and the City shall approve the final project plans once satisfied that all appropriate site-specific design criteria and geotechnical recommendations, including any additional recommendations that come out of this review, have been applied to the implementation of
the project through the project plans. The applicant is required to comply with the recommendations contained in the geotechnical report.

Construction of the proposed project would include ground-disturbing activities that could temporarily expose surficial soils to wind and water erosion. Compliance with applicable regulations, including the implementation of erosion and sediment controls during construction, would ensure that the proposed project would not result in substantial soil erosion of the loss of topsoil.
3.5.1 Introduction

This section provides information about the geologic and seismic conditions of the project site and surrounding area, presents the applicable regulations related to geologic hazards, and identifies potential geologic hazard impacts that may result from implementation of the proposed project. Potential geologic hazards that are evaluated include: ground rupture from surface fault rupture, earthquake induced ground shaking, liquefaction, subsidence, and expansive soil and erosion. The geology and soils analysis is based, in part, on published reports, and the Revised Report of Preliminary Geotechnical Engineering Services for The Waterfront – Redondo Beach Pier, Redondo Beach, California prepared by GeoDesign (see Appendix F).

Soil erosion is also addressed in Section 3.8 Hydrology and Water Quality of this Draft EIR, as is the potential for impacts from tsunamis and sea level rise.

3.5.2 Environmental Setting

3.5.2.1 Regional Setting and General Terminology

Geology

The project site is located within the western coastal area of the Los Angeles Basin (Basin), which is at the juncture of three Southern California physiographic provinces: the Transverse Ranges to the north, the Peninsular Ranges to the east and southeast, and the continental borderland to the west. The Basin is a low-lying plain that rises inland and slopes gently to the south and is bordered by highlands and their foothills, including the Santa Monica Mountains to the north, the Repetto and Puente Hills to the northeast, the Santa Ana Mountains to the east, and the San Joaquin Hills to the southeast. From a geologic perspective, the 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. The Basin is also part of the Peninsular Ranges Province, which extends south of the Santa Monica Mountains to the tip of Baja California. This geomorphic province is characterized by several northwest-trending mountain ranges and faults, separated by straight-sided sediment floored valleys. The Basin is underlain by both marine and nonmarine accumulations of gravel, sand, silt, and clay, that were deposited over time as a consequence of sea level fluctuations and erosion of the landmasses north, east, and south of the Basin. The Los Angeles Basin and the regional faults within the Basin are shown in Figure 3.5-1.

From a mapping perspective, the project site, as well as a majority of the City, is within the State of California Redondo Beach 7.5-Minute Quadrangle, Los Angeles County, California (Redondo Beach Quadrangle) (California Department of Conservation, Division of Mines and Geology, 1998a and 1999). The Redondo Beach Quadrangle includes the shoreline of the Santa Monica Bay from Redondo Beach southward to the Palos Verdes Peninsula, including the coastal portions of Hermosa Beach, Manhattan Beach, Redondo Beach, Torrance, Palos Verdes Estates, Rancho Palos Verdes, and Rolling Hills Estates. Coastal cities were developed on active and inactive coastal sand dunes, while the elevated Palos Verdes Peninsula to the south of the project site is characterized by a series of stair step-like
Pleistocene\(^1\) wave-cut marine terraces. In general, the coastal portion of the City within the Redondo Beach Quadrangle consists of surficial (surface) geologic deposits that are mostly artificial fill (Af) or eolian\(^2\) and dune deposits (Qe) (Figure 3.5-2). The adjacent water area (within the harbor) is Pleistocene sedimentary deposits (Qp). Within the Redondo Beach Quadrangle the liquefaction zone encompasses the beach and a majority of the project site which is an area of artificial fill associated with the King Harbor Development in Redondo Beach (Figure 3.5-3). The Palos Verdes Hills to the south of the project site is where most of the earthquake-induced landslide zone exists due to the steep sea cliffs, canyon walls, edges of marine terraces and large landslide deposits.

Portions of the City not within the Redondo Beach Quadrangle are within the Torrance 7.5-Minute Quadrangle (areas of the City to the east of the Redondo Beach Quadrangle) and the Inglewood 7.5 Minute Quadrangle (areas of the City to the north of the Torrance Quadrangle, near the 405 Freeway and Marine Avenue) (California Department of Conservation, Division of Mines and Geology, 1998b and 1998c). The portions of the City within the Torrance and Inglewood Quadrangles are predominantly within areas of older eolian deposits (Qoe) and are not within the liquefaction zone nor are they within any special seismic fault zone, or landslide zone.

**Seismicity**

When an earthquake occurs, waves of energy are transmitted through the earth, resulting in a variety of seismic effects, including surface rupture, ground shaking, and ground failure such as liquefaction. Surface rupture is most common within the vicinity of a main fault trace and along other faults associated with the main fault. Ground shaking is the phenomenon most readily associated with earthquakes and may be experienced as a violent shuddering or rocking motion or as a gentle nudge. Soil liquefaction is a phenomenon in which saturated soils experience a sudden and nearly complete loss of strength during seismic events. If not confined, the soil acquires sufficient mobility to allow for horizontal and vertical movements. Liquefaction generally occurs in saturated, loose to medium dense, granular soil and in saturated, soft to moderately firm silt because of strong ground shaking. Liquefaction can result in shallow foundation failures, boiling, severe settlement, and failure of fill supported on liquefiable soils. The magnitude of liquefaction-induced settlement depends on the thickness and relative density of the liquefiable soils and the intensity of ground shaking.

An earthquake is classified by the magnitude of wave movement (related to the amount of energy released), which traditionally has been quantified using the Richter scale. This is a logarithmic scale wherein each whole-number increase in magnitude represents a tenfold increase in the wave magnitude generated by an earthquake. Structural damage typically occurs at magnitude 5.0 or greater. One limitation of the Richter magnitude scale is that it has an upper limit at which large earthquakes have about the same magnitude. As a result, the

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\(^1\)The **Pleistocene** is the geologic era from about 2.588 million to 12,000 years ago covering the world’s recent period of repeated glaciations.

\(^2\)Eolian deposits are deposits that form as a result of the accumulation of wind-driven products of the weathering of solid bedrock or unconsolidated alluvial, lacustrine, marine, or other deposits.
Portofino Way
N.HarborDrive
N.CatalinaAvenue
Beryl Street
CarnelianStreet
N.Broadway
DiamondStreet
S.Catalin
aAvenue
Pacific
CoastHighway
Port Royal
Marina
Portofino
Marina
Basin 2
Veterans Park
North (Outer) Breakwater
South Breakwater
Horseshoe Pier
Monstad Pier Plaza and Pier Parking Structure
Hand Launch
AES Power Plant
Czuleger Park
International Boardwalk
N.Pacific
Avenue
Hotel
Seaside Lagoon
Basin 3
Mole D
Boat Hoists
Plaza Parking Structure
Residential Development
Residential Development
T u r n i n g B a s i n
General Surficial Geology
Source: California Geological Survey, 2003; 2010
Figure 3.5-2
Legend
Breakwater Fill Area
Project Area
Existing Structured Public Parking
Artificial fill (Af)
Recent Beach deposits (Qb)
Eolian and dune deposits (Qe)
Old eolian and dune deposits (Qoe)
Pleistocene sedimentary deposits (Qp)
Figure 3.5-3

Legend
- Project Area
- Existing Structured Public Parking
- Breakwater Fill Area
- Liquefaction Hazard Zone

Sources: California Department of Conservation, Division of Mines and Geology, 2002; City of Redondo Beach, 2008; Noble Consultants, Inc., 2015

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Liquefaction Hazard Zone
moment magnitude scale, which does not have an upper limit magnitude, was introduced in 1979; it is often used for earthquakes greater than magnitude 3.5. Earthquakes of magnitude 6.0 to magnitude 6.9 are classified as moderate, those between magnitude 7.0 and magnitude 7.9 are classified as major, and those of magnitude 8.0 or greater are classified as great.

Like most areas in Southern California, the region is located in a seismically active region. The southern half of California is recognized as one of the most seismically active areas in the United States. The region has been subjected to at least 50 earthquakes of magnitude 6 or greater since 1796. Ground motion in the region is generally a result of sudden movements of large blocks of the earth along active faults. The fault with the highest probability of generating at least one magnitude 6.7 quake or larger in the next 30 years is the southern San Andreas Fault, at 59 percent. The probability of a magnitude 6.7 or greater earthquake in the greater Los Angeles area in the next 30 years is 67 percent (2007 Working Group on California Earthquake Probabilities, 2008).

Faults

Faults are categorized by the California Geological Survey (CGS) as active, potentially active, or inactive, according to the most recent seismic activity. An active fault is one that has had surface displacement within Holocene time (approximately the last 11,700 years). A potentially active fault is one that has demonstrated surface displacement of Quaternary age deposits (last 1.6 million years). An inactive fault is one without identified Holocene or Pleistocene Age activity (i.e., no movement within last 1.6 million years).

State of California Earthquake Fault Zones (formerly known as an Alquist-Priolo Special Studies Zones) are typically determined by extending 500 feet in each direction away from known traces of active faults, resulting in a fault zone of 1,000 feet, or more, in width. CGS released a Fault Activity Map (CDS, CGS, 2010) showing the locations of active faults believed to be capable of causing ground surface rupture. According to the Fault Activity Map, the project site is not located within a State of California Earthquake Fault Zone.

Given that the majority of Southern California is located in a seismically active area, the potential for strong earthquake-related ground shaking is considered likely. The sub-regional setting in which the project site is situated includes major faults and fault zones that are generally parallel to the San Andreas Fault Zone, which is located approximately 51 miles to the east. Figure 3.5-1 illustrates the project site location relative to the major faults in the region. The major active faults in the region that contribute to the seismic hazard at the project site are listed in Table 3.5-1.

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3 The Quaternary period is the youngest of three periods of the Cenozoic era in the geologic time scale, and it follows the Neogene period, spanning 2.588 ± 0.005 million years ago to the present. Quaternary includes two geologic epochs: the Pleistocene and the Holocene eras.
### Table 3.5-1: Regional Active Faults*

<table>
<thead>
<tr>
<th>Fault</th>
<th>Significant Historic Earthquakes</th>
<th>Approximate Distance to Project Site (miles)</th>
<th>Estimated Maximum Earthquake Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palos Verdes (offshore segment)</td>
<td>-</td>
<td>0.7</td>
<td>7.3</td>
</tr>
<tr>
<td>Newport-Inglewood (LA Basin)</td>
<td>1933 (M&lt;sub&gt;W&lt;/sub&gt;6.4)</td>
<td>8</td>
<td>7.1</td>
</tr>
<tr>
<td>Santa Monica</td>
<td>-</td>
<td>14</td>
<td>6.6</td>
</tr>
<tr>
<td>Puente Hills (Blind Thrust)</td>
<td>-</td>
<td>15</td>
<td>7.1</td>
</tr>
<tr>
<td>Malibu Coast</td>
<td>-</td>
<td>15</td>
<td>6.7</td>
</tr>
<tr>
<td>Hollywood</td>
<td>-</td>
<td>17</td>
<td>6.4</td>
</tr>
<tr>
<td>Upper Elysian Park (Blind Thrust)</td>
<td>-</td>
<td>18</td>
<td>6.4</td>
</tr>
<tr>
<td>Anacapa-Dume</td>
<td>-</td>
<td>20</td>
<td>7.5</td>
</tr>
<tr>
<td>Raymond</td>
<td>-</td>
<td>22</td>
<td>6.5</td>
</tr>
<tr>
<td>Northridge (E. Oak Ridge)</td>
<td>1994 (M&lt;sub&gt;W&lt;/sub&gt;6.7)</td>
<td>22</td>
<td>7.0</td>
</tr>
<tr>
<td>Verdugo</td>
<td>-</td>
<td>24</td>
<td>6.9</td>
</tr>
<tr>
<td>Whittier</td>
<td>1987 (M&lt;sub&gt;W&lt;/sub&gt; 6.1) – along Elsinore-Whittier fault</td>
<td>24</td>
<td>6.8</td>
</tr>
<tr>
<td>Sierra Madre</td>
<td>-</td>
<td>28</td>
<td>7.2</td>
</tr>
<tr>
<td>San Joaquin Hills</td>
<td>-</td>
<td>28</td>
<td>6.6</td>
</tr>
<tr>
<td>Sierra Madre (San Fernando)</td>
<td>-</td>
<td>30</td>
<td>6.7</td>
</tr>
<tr>
<td>San Jose</td>
<td>1990 (M&lt;sub&gt;L&lt;/sub&gt;5.4)</td>
<td>32</td>
<td>6.4</td>
</tr>
<tr>
<td>Newport-Inglewood (offshore segment)</td>
<td>-</td>
<td>32</td>
<td>7.1</td>
</tr>
<tr>
<td>Clamshell-Sawpit</td>
<td>1991 (M&lt;sub&gt;L&lt;/sub&gt;5.8)</td>
<td>32</td>
<td>6.5</td>
</tr>
<tr>
<td>Santa Susana</td>
<td>1971 (M&lt;sub&gt;W&lt;/sub&gt;6.5)</td>
<td>33</td>
<td>6.7</td>
</tr>
<tr>
<td>San Gabriel</td>
<td>-</td>
<td>34</td>
<td>7.2</td>
</tr>
<tr>
<td>Chino-Central Avenue (Elsinore)</td>
<td>-</td>
<td>35</td>
<td>6.7</td>
</tr>
<tr>
<td>Simi-Santa Rosa</td>
<td>-</td>
<td>36</td>
<td>7.0</td>
</tr>
<tr>
<td>Holser</td>
<td>-</td>
<td>38</td>
<td>6.5</td>
</tr>
<tr>
<td>Oak Ridge (onshore segment)</td>
<td>-</td>
<td>40</td>
<td>7.0</td>
</tr>
<tr>
<td>Cucamonga</td>
<td>-</td>
<td>43</td>
<td>6.9</td>
</tr>
<tr>
<td>Elsinore (Glen Ivy)</td>
<td>1910 (M&lt;sub&gt;L&lt;/sub&gt;6.0)</td>
<td>43</td>
<td>6.8</td>
</tr>
<tr>
<td>San Cayetano</td>
<td>-</td>
<td>46</td>
<td>7.0</td>
</tr>
<tr>
<td>Coronado Bank</td>
<td>-</td>
<td>47</td>
<td>7.6</td>
</tr>
<tr>
<td>Oak Ridge (blind thrust offshore)</td>
<td>-</td>
<td>49</td>
<td>7.1</td>
</tr>
</tbody>
</table>

*Note: Estimated maximum earthquake event magnitudes are based on historical records and geological analysis.
Table 3.5-1: Regional Active Faults*

<table>
<thead>
<tr>
<th>Fault</th>
<th>Significant Historic Earthquakes</th>
<th>Approximate Distance to Project Site (miles)</th>
<th>Estimated Maximum Earthquake Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel Islands (thrust – eastern)</td>
<td>-</td>
<td>51</td>
<td>7.5</td>
</tr>
<tr>
<td>San Andres</td>
<td>1857 (Mw7.9)</td>
<td>51</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Source: EQFAULT Version 3.00 – Deterministic Estimation of Peak Acceleration From Digitized Faults (performed April 2015); Southern California Earthquake Data Center, 2015

Notes:

* Table 3.5-1 presents an overview of the regional active faults and its proximity and seismic activity history. The location of these faults are shown in Figure 3.5-1.

Mw - Moment magnitude scale
ML - Richer scale

Liquefaction

When loosely packed or deposited granular soils are subjected to seismic shaking in proximity to water (such as groundwater), a process called liquefaction can occur. This phenomenon typically occurs in loose, saturated sediments of primarily sandy composition with ground acceleration due to gravity (g) of more than 0.2 g. This ground shaking of sufficient duration results in the loss of grain-to-grain contact due to increase in pore water pressure. As the density and/or particle size of the soil increases, the potential for liquefaction decreases. When this occurs, the sediments involved have a total or substantial loss of shear strength and behave more like a liquid or semi-viscous substance. This can cause ground settlement, foundation failures, and a buoyant rise of buried structures. When soil liquefies, loss of bearing strength may occur beneath a building/structure, possibly causing buildings to settle or tilt.

Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below ground surface (bgs). Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

Lateral Spreading

Lateral spreading of the ground surface during a seismic activity may occur when potentially liquefiable soil is present in conjunction with a sloping ground surface and a “free” face (i.e., retaining wall, slope, or channel). Ground shaking leading to liquefaction of saturated soil can result in lateral spreading where the soil undergoes a temporary loss of strength. If soil within the slope liquefies, the result may be temporary instability resulting in deformation or translation of the slope. In order for this to occur, the liquefiable soil needs to be continuous and the toe of the slope needs to be unsupported. Lateral spreading can result in damage to pipelines and utilities.
Subsidence

Land subsidence is a gradual settling or sudden sinking of the ground surface elevation due to subsurface movement of soils and other earth materials. Fill and native materials can be water saturated, and a net decrease in the pore pressure and contained water will allow the soil grains to pack closer together. This closer grain packing results in less volume and the lowering of the ground surface. More than 80 percent of identified subsidence in the United States is caused through overdrafting of groundwater. Drainage of organic soils, underground mining, natural compaction, and thawing of permafrost can also cause subsidence. Subsidence causes large areas of land to sink, thereby potentially damaging foundations, walls, and floors.

Erosion

Erosion is a condition that can significantly and adversely affect development on any site. Buildings/structures located above or below actively eroding natural slopes or manufactured slopes could be susceptible to the effects of erosion. In addition, development could exacerbate erosion conditions, if they exist, by exposing soils and adding additional water to the soil from irrigation and runoff from new impervious surfaces.

Unstable/Compressible Soils

Compressible soils are fine-grained soils (silts and clays) that are susceptible to decreasing in volume (i.e., they compress) when weight is placed on them. The settlement of compressible silts and clays is referred to as consolidation, which occurs when groundwater is squeezed from soil pores by added surface loads, such as fills or building foundations. The amount and rate of settlement can vary greatly, depending on a number of factors, including natural moisture and density, the thickness of the compressible layer, the amount of fill placed over the compressible material, and the ability of pore water to escape from soil pores through drainage paths such as sand lenses and soil fissures.

Expansive Soils

Fine-grained soils (silts and clays) may contain variable amounts of expansive minerals. These minerals can undergo significant volume changes as a result of changes in moisture content (i.e., they expand when they get wet and shrink as they dry out). This expansive behavior (changes in the water content of an expansive soil) can result in severe distress to buildings and infrastructure constructed upon the soil, which can damage foundations and other building components. Problems associated with expansive soils include foundation damage, jammed doors and windows, ruptured pipelines, and heaving and cracking of sidewalks and roads. Fine-grained sediments with high clay content would be most susceptible to potential expansive soil impacts. Further, expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula as well as associated with clayey soils in artificial fill.

Corrosive Soils

Corrosive soils contain chemical constituents that can react with construction materials, such as concrete and ferrous metals (metals containing iron), which may damage foundations and buried pipelines. The electrochemical corrosion processes that take place on metal surfaces in soils occur in the groundwater that is in contact with the corroding structure. Soil moisture, chemistry, aeration, physical characteristics, bacteria, etc., have important effects on corrosion. In general, fine-grained soils have higher corrosion potential due to the smaller particle size that results in greater surface area with high chemical and moisture affinity.
3.5.2.2 Site Conditions

Subsurface Conditions

Based on geologic exploration at the project site, the site-specific subsurface geology of the landside portion of the project site is characterized by four primary geologic materials: artificial fill, recent beach deposits, lagoon-type deposits, and geographically older (Pleistocene) marine terrace deposits. Following is a definition of the four primary subsurface geologic materials (deposits) within the landside of the project site:

Artificial Fill (Af): Generally Af consists of undifferentiated old and new fills associated with the development of the harbor and consists of loose and/or soft to firm and/or dense granular sand and silty sand. This artificial fill is not characterized as either clayey or expansive.

Recent Beach Deposits (Qb): Qb deposits consist of shell fragments and are relatively clean, loose sand.

Lagoon-type deposits: Lagoon-type deposits consist of fine-grained silt and clay.

Pleistocene age marine/sedimentary deposits (Qp): These deposits are older marine terrace deposits that generally consist of dense, fine sand with noticeably fewer shell fragments than found in Qb deposits.

The adjacent water area includes a transition area of varying width (adjacent to the shore) that includes lagoon-type deposits. Further from the shore, the surficial geology is Qp (CDC, CGS, 2003).

The unconsolidated sands associated with the project site are the result of basin uplift, subsidence, and re-filling with sediments. Refer to Figure 3.5-2, for the location of Af, Qb and Qp at the project site, and Figure 3.5-4, for the location of the subsurface geologic deposits at the project site, including the lagoon-type deposits.

Development of the harbor has modified these native sediments to create a waterfront area of Af material that supports its marine facilities. Consequently, as shown in Figure 3.5-2, most of the project site lies on fill material.

For geology and soils discussion, the project site is divided into three general areas: Northern, Southern and Basin 3. Following is a summary of the subsurface conditions associated with each of the areas:

Northern Portion of Project Site

Preliminary landside subsurface explorations within the northern portion of the project site indicated relatively loose, granular deposits in the upper approximately eight to 24 feet bgs. These upper deposits are likely representative of the upper fill and recent beach deposits. At these locations, the relatively loose, granular deposits were typically underlain by a four- to five-foot-thick layer of fine-grained deposits, representative of the still-water lagoon deposits. Below the lowest lagoon deposits encountered within the northern portion of the project site, relatively dense, granular deposits were encountered, representative of the Pleistocene marine deposits.
Legend
- Breakwater Fill Area
- Project Area
- Existing Structured Public Parking
  - Existing Topography
  - Cone Penetrometer Test
  - Interpreted Contact
- Assumed Groundwater Level
- Span of Cross Section (see insets)
- Upper Fill
- Fine-grained Lagoon Deposits
- Loose Granular Beach Deposits
- Dense Granular Marine Deposits

Source: GeoDesign, Inc., 2014
Preliminary Results – For discussion purposes only
The water area of the northern portion of the project site (i.e., location of the proposed small craft boat launch ramp facility and area of Seaside Lagoon and Sportfishing Pier) is within an area mapped as having Qp geologic materials.\(^4\)

**Southern Portion of Project Site**

Preliminary landside subsurface explorations within the southern portion of the project site found two distinct subsurface zones. The northern area – from approximately the Pier Parking Structure toward Basin 3 encountered approximately nine feet of loose or soft soil underlain by relatively dense soil and encountered an impenetrable layer (possibly of riprap associated with old shoreline and/or prior marine foundation elements) at relatively shallow depths of between 14 to 22 feet bgs. In the southern area, within Pier Plaza and Pier Parking Structure, subsurface explorations found very dense granular soil was encountered, representing the Pleistocene age marine terrace deposits.

With the exception of the sand beach along the shore of the pier area, the water area of the southern portion of the project site (i.e., Horseshoe Pier area) is mapped as having Qp geologic materials.\(^5\)

**Basin 3**

In 1976, an investigation of subsurface conditions was performed in association with Basin 3 bulkhead rehabilitation (Moffatt & Nichol, 1976). Sampling associated with the water area of Basin 3 indicated a layer of fill. The fill consisted of loose to medium dense sand, with pieces of asphalt concrete, brick, wood, etc. Native soils consisting of predominantly dense to very dense sand and silty sand with isolated layers of soft to stiff peat, organic, silt, and sandy silt were encountered to the depths explored.

**Geologic and Seismic Hazards**

This section includes a general discussion of existing risks on the project site associated with faults, strong seismic ground shaking, seismic related ground failure (i.e., liquefaction), and unstable geologic units and/or soils.

**Faults**

The project site is located in a seismically active area, as is the majority of Southern California and the potential for strong earthquake-related ground shaking is considered likely. The sub-region in which the project site is situated includes major faults and fault zones that are generally parallel to the San Andres Fault Zone, which is located farther to the east. The area surrounding the project site is characterized by major faults and fault zones that are generally parallel to the San Andreas Fault Zone. The closest active fault to the project site is the Palos Verdes Fault (offshore portion) at approximately 0.7 mile to the west (in the Pacific Ocean). The nearest landside active fault is the Newport-Inglewood Fault at approximately eight miles to the east. The Newport-Inglewood Fault System is over 75 miles in length. According to the Fault Activity Map (which shows the locations of active faults believed to be capable of causing ground surface rupture), the project site is not located within a State of California

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\(^4\) Although the harbor/water area consists generally of Qp geologic materials, closer to shore it is expected that a variable transition area exists within the harbor that has lagoon-type deposits that lead to Qp geologic materials.

\(^5\) Ibid
Earthquake Fault Zone; therefore, the potential for ground surface rupture at the project site is considered to be very low.

Figure 3.5-1 illustrates the project site location relative to the major faults in the region. The major faults in the region that contribute to the seismic hazard at the project site are listed in Table 3.5-1.

**Liquefaction**

As shown in Figure 3.5-4, a majority of the project site is located within a liquefaction hazard zone due to the combination of shallow groundwater and geologically recent deposits. The groundwater level at the project site corresponds roughly with the tidal level in the harbor and can be expected to be within 5 to 10 feet bgs at the site. The historical highest groundwater was adjacent to the site (adjacent to the eastern site boundary) at 10 feet bgs (California Department of Conservation, Division of Mines and Geology, 1998a).

During the 1994 Northridge earthquake, liquefaction settlement was observed at King Harbor Mole B (Basin 2) parking lot (located north of the project site). The closest ground motion station to the project site, located approximately 2.8 miles to the north, recorded a maximum horizontal ground acceleration of 0.16 g. Based on a preliminary ground motion study that determines seismic hazard potential, the predominant earthquake magnitude for the project site is 7.19 with a peak ground acceleration (PGA, expressed in g) equal to 0.537. Based on results of a preliminary liquefaction evaluation, the liquefaction settlement potential is high (approximately eight inches estimated for the upper granular soil) within the northern portion of the project site and transitional zone that extends into the southern portion of the project site. Liquefaction potential of the dense granular soil anticipated in a majority of the southern portion of the site (in particular the area associated with the Pier Plaza and Pier Parking Structure) is relatively low.

**Lateral Spreading**

Lateral spreading can occur when potentially liquefiable soil is present in sloping ground that daylights or is unsupported. During the 1994 Northridge earthquake, lateral spreading occurred in the nearby Mole B (Basin 2 - north of the project site) resulting in lateral translation of about 20 feet when a 500-foot section of a seawall and rock mound moved horizontally (laterally) as a result of the earthquake (see Photograph 3.5-1 below).
In addition, utility lines and a nearby sidewalk required repairs, and the Seaside Lagoon required repairs due to damage sustained from the Northridge earthquake. Based on existing information, overall there is a potential for lateral spreading at the project site.

**Subsidence**

Based on estimates performed for the proposed project, ground subsidence for unsaturated sands was approximately three to six inches within existing soil due to the placement and compaction of new fill soil. Seismic settlement in unsaturated dry soil is minimal and settlement negligible since the groundwater level at the project site is high.

**Erosion**

Erosion and the loss of topsoil could occur during implementation of the proposed project due to the proposed improvements involving pavement removal and repaving as these activities could result in the temporary exposure and loss of soils. Currently, the potential for significant soil erosion or loss of topsoil without implementation of the proposed project is very low because the majority of the project area is paved.

**Unstable Soils**

Natural alluvial and estuarine deposits, as well as imported fill consisting of dredged deposits or of imported soils, comprise the soil in the area including the project site. The site is currently subject to lateral spreading, subsidence, liquefaction, or collapse and can become unstable.

**Expansive Soils**

Fine-grained sediments with high clay content would be most susceptible to potential expansive soil impacts. Expansive clay minerals are common in the geologic units in the adjacent Palos Verdes Peninsula. Although no clayey expansive soil was present on the project site based on available data, if clayey expansive soil is encountered above high groundwater, the cycle of cracks developed during dry season and wetting due to irrigation and/or wet season could cause settlement and ground heave that can potentially be detrimental to shallow and surficial structures.

**Corrosive Soils**

In general, fine-grained soils have higher corrosion potential due to the smaller particle size that results in greater surface area with high chemical and moisture affinity. Based on the available subsurface data, relatively granular deposits were encountered in the upper soils across the project site. Fine-grained soils associated with lagoon-type deposits, which have some potential to be corrosive, maybe encountered in the northern portion of the project site.

### 3.5.2.3 Existing Structural Conditions

Following is an overview of the existing buildings/structures on the project site:

**Northern Portion of the Project Site**

The northern portion of the project site includes large surface parking lots with several building pads consisting primarily of restaurants. Other features include the Seaside Lagoon, the Sportfishing Pier (also known as “Polly’s Pier”), a hand launch (non-motorized/hand carried boats only) and dinghy dock, a Galveston break wall, two boat hoists, a portion of the Plaza Parking Structure and public areas west of the Plaza Parking Structure. Following is a description of the existing condition of the major buildings/structures within the northern portion of the project site:
Buildings: There are six stand-alone restaurants located throughout the northern portion of the site. In addition, there is a rectangular shaped building located on the Sportfishing Pier that includes a restaurant, a sport fishing charter business, and public restroom. Based on building permit records, original construction of the buildings occurred at various times between the 1960’s and 1990’s. Due to changes in tenants, various minor improvements (such as upgrading equipment and other tenant-specific improvements) have been made over the years. Although most of the buildings appear to be in fair condition, due to current CBC requirements being more stringent than when the buildings were originally built, these facilities likely do not meet the current code requirements.

Sportfishing Pier: The pier is an approximately 245-foot long and 30-foot wide wooden (timber) pier constructed in 1969. Since its original construction 46 years ago, the pier has reportedly undergone numerous inspection and maintenance repairs. Typical repairs included wrapping piles with polyethylene sheets and replacing braces. The most recent structural inspection for the pier was performed in 2007 and found the pier structure to be in decline, and specifically various pilings were found to be in bad condition (e.g., voids and worm damage), as well as the ramps and topside decking being in poor condition (Marine Tech Engineering, Inc., 2007). In January 2015, a walk through inspection (limited to visual observations of the structural components under the deck and above the waterline) of the pier was completed. In summary, the 2015 inspection found the condition of the lower horizontal and diagonal bracing under the pier is very poor and all fender piles and at least six timber piles is also very poor. Since the 2007 inspection when these deficiencies were documented, it is estimated that additional piles beneath the footprint of the building may also now need to be repaired or replaced. Any attempt to repair or replace existing piles was determined to require demolition of a portion of the building and deck to sufficiently expose the bottom and allow equipment to excavate the stone, temporarily set it aside, and replace the pile. Given the number of piles that ultimately need to be repaired or replaced, at least one-half of the building and pier would end up needing to be removed. This essentially translates to nearly total demolition and replacement of the existing pier and building (Noble, 2015b).

Plaza Parking Structure: The Plaza Parking Structure was constructed in 1981. The structure consists of an exposed upper parking level referred to as the Plaza Level (this level is used for pedestrian traffic only), the mid-level is referred to as the Pier Level, and the lowest level is referred to as the Basin Level. Repairs and maintenance have occurred at various times throughout the service-life of this parking structure. A conditions assessment performed in June/July 2011 determined that overall the structure is in good condition (Walker Restoration Consultants, 2012). The condition of the structure is worse along the ocean side (the degradation of the materials and structure is associated with the proximity to the ocean) and the Pier Level, which requires localized overhead and floor slab concrete and beam/girder repairs.

Southern Portion of the Project Site

The southern portion of the project site encompasses the Horseshoe Pier and retail and restaurant buildings located on the pier, the Pier Parking Structure, and Pier Plaza (the two-level commercial and office development on the upper level of the parking structure) and the International Boardwalk (commercial development located along Basin 3), including restaurants and an arcade. Following is a description of the existing condition of the major structures within the southern portion of the project site:
Buildings: The existing commercial buildings in the southern portion of the project site primarily consist of shops and restaurants along the Horseshoe Pier and Basin 3 (i.e., International Boardwalk). With the exception of Kincaid’s restaurant (located at the northern end of the pier), the commercial/restaurant space (mostly tourist shops, restaurants and bars) on the Horseshoe Pier is mostly in the southern section of the pier. Kincaid’s was built in the early 2000s and is in very good condition. The buildings in the southern portion of the pier were built in the 1950’s and 1960’s and appear tired/aged and in need of substantial rehabilitation.

The International Boardwalk is a narrow strip of small shops and restaurants located along a paved access road east of Basin 3. The International Boardwalk, constructed in the 1960s, is characterized by small tourist shops, restaurants and bars. In general, the boardwalk area appears run down and is subject to flooding during high tides and storm conditions due to its location adjacent to the Redondo Beach Marina/Basin 3.

In 1979-1980, the buildings currently situated on the upper deck of the Pier Parking Structure were built. Although originally a retail center called Seaport Village, by the end of the 1980s the complex was largely converted to office uses and renamed Pier Plaza. These buildings appear to be in fair condition.

Similar to the buildings in the northern portion of the project site, due to changes in tenants, various minor improvements (such as upgrading equipment and other tenant-specific improvements) have been made over the years. With the exception of Kincaid’s, a majority of the buildings within the southern portion of the project site likely do not meet the current code requirements.

Horseshoe Pier: In 1988, a fire destroyed the northern and center portions of the pier. The damaged portions of the pier were subsequently reconstructed (with a concrete deck) with the restored pier opening in 1995. The southern area of the pier that was not damaged in the fire (currently the location of shops, restaurants and bars) consists of the 1928 portion of the pier (which consists of a wooden/timber deck). A comprehensive visual inspection of the timber piers was performed for the City in January 2015. As a whole, the inspection concluded that although portions of the pier shows signs of deterioration and areas needing replacement or repair, particularly related to the 1928 timber portion, the pier overall is in fair condition. The inspection of the 1928 timber portion of the pier (an area of approximately 18,500 square feet) concluded that the timber pier is very near to or at the end of its useful service life. Although repair and maintenance has occurred over the years, the 1928 portion of the pier is aged and does not meet the current code requirements. The continued obligation and ability to repair and maintain the aged structure is severely constrained by the existing buildings, limited access, and the pier’s constant exposure to storm waves and surf. Because of these constraints, current repair methods would be less effective unless the existing buildings are removed to better access the work area so that the structural members can be properly replaced. The newer concrete portion of the pier is approximately 20 years old and is considered to be in good condition (Noble, 2015a).

Pier Parking Structure: The Pier Parking Structure is made up of the North Pier Parking Structure and the South Pier Parking Structure, which are currently operated as one parking structure. Both the north and south structures have three levels: Village Level (an exposed upper level); Pier Level (mid-level); and, Basin Level (lower level). The North Pier Parking Structure was reportedly completed in 1960’s and the South Pier Parking Structure was constructed in 1973. A conditions assessment was performed in June/July 2011 and an
additional structural analysis was performed for the northern portion of the structure in June 2012. The assessment found the North Pier Parking Structure to be in poor condition and the South Pier Parking Structure to be in better condition (Walker Restoration Consultants, 2012). Conditions within the parking structure are significantly worse along the ocean side (the degradation of the materials and structure is associated with the proximity to the ocean). Repairs and maintenance have occurred at various times throughout the service-life of this parking structure; however, the underlying deterioration remains. The parking structure has areas of loose or delaminated concrete in danger of falling and substantial repairs are required, including necessary changes that are required to the Pier Plaza structures on the upper/Village Level that are leaking and contributing to increasing deterioration within the South Pier Parking Structure. Major repairs are required throughout the parking structure, including localized overhead and floor slab concrete and beam/girder repairs, and seismic strengthening.

**Basin 3**

Basin 3 is a water area occupied by the Redondo Beach Marina. It has 53 vessel slips utilized for long term moorage by recreational, commercial, fishing, tourism, and excursion vessels, as well as approximately six residents (referred to as “liveaboards”). In general, Basin 3 consists of a bulkhead (a seawall) and slips. The bulkhead was built in the 1960’s. In January 2015, a bulkhead inspection was performed (Noble, 2015c). In general the existing bulkhead wall appears to be in good condition, with deterioration (i.e., advanced stage of corrosion) being confined mainly to the concrete cap. In addition, based on the 1960 design, the bulkhead does not meet current code requirements and may be deficient in its ability to resist a severe earthquake. The vessel slips are in poor condition and at the end of their service life.

### 3.5.3 Regulatory Framework

#### 3.5.3.1 Alquist-Priolo Earthquake Fault Zone Act

The CGS has delineated earthquake fault zones deemed active and likely to rupture the ground surface pursuant to the Alquist-Priolo Earthquake Fault Zoning Act of 1972 (California Department of Conservation [CDC], 1972). Mapping the fault zones is intended to minimize the chance for buildings used for human occupancy to be built over active faults. This is accomplished by requiring a geological investigation for new development located within designated active earthquake fault zones. For purposes of implementing the Act, it is assumed that the area within 50 feet of an active fault is underlain by active branches of the fault, until a geotechnical evaluation has determined otherwise. Based on the available geologic data and a preliminary geotechnical evaluation, active or potentially active faults with the potential for surface fault rupture are not known to be located directly beneath or projecting toward the project site.

#### 3.5.3.2 Seismic Hazards Mapping Act of 1990

The California State Seismic Hazards Mapping Act of 1990 addresses earthquake hazards other than surface fault rupture, including liquefaction and seismically induced landslides (CDC, 1990). Through it, the state establishes city, county and state agency responsibilities for identifying and mapping seismic hazard zones and mitigating seismic hazards to protect public health and safety. It requires the California Geological Survey to map seismic hazards and establishes specific criteria for project approval that apply within seismic hazard zones. The project site is located within a seismic hazard zone (i.e., liquefaction zone) but not within an Alquist-Priolo fault zone. Projects within seismic hazard zones must generally prepare a geotechnical report pursuant to this Act.
3.5.3.3 California Building Code

The proposed project would be required to comply with the California Building Code (CBC) codified in Title 24 California Code of Regulations. CBC, Part 2, Volume 2, Chapter 18, Soils and Foundations, outlines the minimum standards for structural design and construction. The CBC augments and supersedes the Uniform Building Code (UBC) with stricter requirements to reduce the risks associated with building in seismic zones to the maximum extent practicable. The CBC is modeled after the International Building Code (IBC) and sets standards for the investigation and mitigation of the site conditions related to fault movement, liquefaction, landslides, differential compaction/seismic settlement, ground rupture, ground shaking, tsunami, seiche, and seismically induced flooding. Most of the State of California, including the project site, lies within Seismic Zone 4, the highest-level hazard zone designated by the current CBC.

Chapter 18, Soils and Foundations, of the CBC requires that geotechnical evaluations be conducted that include, among other requirements, a record of the soil profile, evaluation of active faults in the area, and recommendations for foundation type and design criteria that address issues as applicable such as (but not limited to) bearing capacity of soils, provision to address expansive soils and liquefaction, settlement and varying soil strength. If a building department, or other appropriate enforcement agency, determines that recommended action(s) presented in the geotechnical evaluations are likely to prevent structural damage, the approved recommended action(s) must be made a condition to the building permit (Section 1803.1.1.3 of Chapter 18).

The CBC provides standards for various aspects of construction, including but not limited to excavation, grading, and earthwork construction; preparation of the site prior to fill placement, specification on fill materials and fill compaction and field testing; retaining wall design and construction, foundation design and construction; and seismic requirements. It includes provisions to address issues such as (but not limited to) construction on expansive soils, liquefaction potential, and soil strength loss. In accordance with California law, project design and construction would be required to comply with provisions of the CBC.

The City requires that projects, including the proposed project, be designed to at least the minimum standards required in the latest version of the CBC at the time of project construction. The CBC bases its seismic design criteria on maximum considered ground motion through maps prepared by the U.S. Geological Survey (USGS) for the National Seismic Hazard Mapping Program (see Section 1613). Chapter 18 (Soils and Foundations) and Appendix J (Grading) of the CBC has also been adopted by the City to establish grading and foundation standards. Standards include requirements for excavation, fill, footings, retaining walls, and pier and pile foundations. Pursuant to the most current CBC, soils reports are required to be submitted prior to issuance of grading permits.

3.5.3.4 State Water Resources Control Board

Regarding soil erosion or the loss of topsoil, the State Water Resources Control Board (SWRCB) requires a National Pollution Discharge and Elimination System (NPDES) general permit for construction activities. A requirement of the NPDES permit includes the preparation of a Stormwater Pollution Prevention Plan (SWPPP) prior to the start of construction activities. Under the SWRCB’s Construction General Permit (CGP), construction projects involving surface disturbance of one acre or more are required to prepare a SWPPP that specifies best management practices (BMPs) to address and avoid or minimize...
construction-related stormwater impacts. The SWPPP is required to include a menu of BMPs to be selected and implemented based on the phase of construction and the weather conditions to effectively control erosion, sediment, and other construction-related pollutants to meet the Best Available Technology Economically Achievable and Best Conventional Pollutant Control Technology standards. Erosion control BMPs are designed to prevent erosion, whereas sediment controls are designed to trap sediment once it has been mobilized. The following types of BMPs, as applicable, would be implemented during construction:

**Erosion Control**

- Physical stabilization through hydraulic mulch, soil binders, straw mulch, bonded fiber matrices, and/or erosion control blankets (i.e., rolled erosion control products).
- Soil roughening of graded areas (through track walking, scarifying, sheepsfoot rolling, or imprinting) to slow runoff, enhance infiltration, and reduce erosion.
- Wind erosion (dust) control through the application of water or other dust palliatives as necessary to prevent and alleviate dust nuisance.

**Sediment Control**

- Perimeter protection through silt fences, fiber rolls, gravel bag berms, sand bag barriers, and straw bale barriers.
- Storm drain inlet protection.
- Sediment capture through sediment traps, storm drain inlet protection, and sediment basins.
- Velocity reduction through check dams, sediment basins, and/or outlet protection/velocity dissipation devices.
- Reduction in off-site sediment tracking through stabilized construction entrance/exit, construction road stabilization, and/or entrance/exit tire wash.

The Los Angeles Regional Quality Control Board (LARWQCB) oversees implementation and enforcement of construction and industrial general permits related to stormwater discharge. The City is covered under the Permit for Municipal Storm Water and Urban Runoff Discharges within Los Angeles County (the Los Angeles County Municipal Storm Water Permit, Order No. 01-182) and is obligated to incorporate provisions of this document in City permitting actions. The municipal permit (also referred to as the MS4 Permit) incorporates requirements low impact development (LID) requirements for operation of a project, which includes implementation of treatment control BMPs for projects falling within certain development and redevelopment categories. Post-construction BMPs may include use of soil binders (chemical stabilization), ground cover (low-growing sprawling plants to stabilize disturbed soil), wood mulching (mixture of shredded wood mulch, bark or compost), and hydroseeding (mixture of wood fiber, seed, fertilizer, and stabilizing emulsion), which are all intended to temporarily protect exposed soils from erosion by water and wind. Refer to

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Section 3.8 Hydrology and Water Quality, for details on stormwater quality, including permanent BMPs for redevelopment projects, such as the proposed project.

### 3.5.3.5 South Coast Air Quality Management District (SCAQMD) – Rule 403 Fugitive Dust

Relative to wind erosion, SCAQMD Rule 403 requires the implementation of best available fugitive dust control measures during active operations capable of generating fugitive dust emissions from on-site earth-moving activities, construction/demolition activities, and construction equipment travel on paved and unpaved roads (see SCAQMD Rule 403(d)(2)).

During project construction, best available control measures identified in the rule would be required to minimize fugitive dust emissions from proposed earth-moving and grading activities. SCAQMD Rule 403, Table 1 provides specific measures for construction activities to reduce fugitive dust, which includes site prewatering and rewatering as necessary to maintain soil stabilization, use of tarps to enclose haul trucks, stabilizing sloping surfaces using soil binders until vegetation or ground cover effectively stabilizes slopes, hydroseed prior to rain, washing mud and soils from equipment at the conclusion of trenching activities. Water usage for dust suppression is accomplished with non-potable water, and furthermore, SCAQMD has adopted guidance “increasing reliance on non-toxic chemical dust suppressants to stabilize soil.”

### 3.5.3.6 City of Redondo Beach - Stormwater and Urban Runoff Pollution Control Regulations

All development projects in the City are required to comply with the City’s Stormwater and Urban Runoff Pollution Control Regulations (RBMC Title 5, Chapter 7). Under Title 5, Chapter 7, development projects are required comply with the Municipal NPDES permit to lessen water quality impacts of development by using smart growth practices and integrating LID practices and standards. Based on the size of the proposed redevelopment associated with the proposed project, it is classified as a Planning Priority Project. Planning Priority Projects are subject to City conditioning and approval for the design and implementation of post-construction pollutant controls and must be designed to control pollutants, pollutant loads, and runoff volume to the maximum extent feasible through minimization of impervious surface areas and through evapotranspiration, infiltration, bioretention, and/or rainfall harvest and use.

Regardless of construction site size, the City through its Municipal Code requires all construction sites to comply with minimum BMPs during construction. As noted above, construction sites with surface disturbance of one acre or more seeking coverage under the state’s CGP must also comply with the requirements of the state. All priority projects are required to prepare a local stormwater pollution prevention plan (LSWPPP). LSWPPP’s must include the SWPPP requirements specified in the CGP. If a construction site for a priority project is disturbed during the rainy season, October 15 through April 15, then a Wet Weather Erosion Control Plan (WWECP) is required. The LSWPPPs and WWECPs must identify

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BMPs to be implemented to avoid stormwater quality issues from erosion and sediments.

The City maintains policies on site maintenance during construction, which requires the use of approved grading and erosion control protection devices during the rainy season between November 1st and April 15th (City of Redondo Beach, 2015). Refer to Section 3.8 Hydrology and Water Quality for details on BMPs associated with various activities that have the potential to affect water quality in King Harbor.

3.5.4 Impacts and Mitigation Measures

3.5.4.1 Methodology

The description of the environmental setting in Section 3.5.2.2 and 3.5.2.3, Environmental Setting, was used as the baseline physical conditions by which significant potential impacts were evaluated. Specifically, the analysis addresses the potential for construction and operation of the proposed project to increase the consequences of adverse geologic conditions and hazards including earthquake-induced ground shaking, earthquake fault surface rupture, earthquake-induced liquefaction, erosion, and unstable, expansive, and corrosive soils.

Available maps and reports identifying geology, faults and earthquake (seismic) hazards in the project area, including the City of Redondo Beach documents and published reports by the CGS and USGS, and others, as well as a project-specific geotechnical engineering report, were reviewed for information regarding geologic hazards within the project site. The evaluation of erosion impacts considers the potential erosion due to construction (based on an analysis of estimated earthwork quantities), as well as from opening Seaside Lagoon. Soil erosion is also addressed in Section 3.8 Hydrology and Water Quality.

To assess whether a given geologic hazard would result in a significant impact, the major components of the proposed project are reviewed and compared with the potential geologic hazards identified and the conditions of the existing buildings/structures. Based on this review, the potential for individual project components to cause new geologic hazards or accelerate existing ones are evaluated.

For the purposes of the environmental analysis, the proposed project is assumed to comply with existing regulatory controls. As applicable, proposed project elements would be implemented in accordance with the CBC provisions associated with seismically-induced geological hazards. This includes 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. Necessary permits, plan checks, and inspections are also specified. The project also incorporates structural seismic requirements of the CBC, which classifies almost all of coastal California (including the project site) as Seismic Zone 4, on a scale of 1 to 4, with four being most severe. The City engineers would review the proposed project plans for compliance with the appropriate standards in the building codes.
3.5.4.2 Thresholds of Significance

The proposed project would result in significant impacts related to geology and soil if it would:

GEO-1: Expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death involving 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, strong seismic ground shaking, or seismic-related ground failure.

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

GEO-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 a significant impact due to on-site or off-site lateral spreading, subsidence, liquefaction, corrosiveness, or collapse.

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

3.5.4.3 Impacts and Mitigation

Proposed Project

The main components of the proposed project include the proposed demolition of approximately 207,402 square feet of existing buildings/structures, demolition of the existing Pier Parking Structure, demolition and possible reconstruction in kind of the Sportfishing Pier, construction of up to approximately 511,460 square feet to include retail, restaurant, creative office, specialty cinema, a public market hall, and a boutique hotel and retention of approximately 12,479 square feet of existing buildings/structures, resulting in approximately 304,058 square feet of net new development. The proposed project also includes proposed enhancements to public recreation and open space, including a new boat launch ramp (for small craft), the opening of Seaside Lagoon to King Harbor as a protected beach (currently the lagoon is not directly connected to the ocean), as well as new and expanded pedestrian and bicycle pathways. Site connectivity and coastal access would be increased by the establishment of a new pedestrian/bicycle bridge across the Redondo Beach Marina/Basin 3 entrance, a new pedestrian boardwalk along the water’s edge from the base of the Horseshoe Pier to Seaside Lagoon, and the Pacific Avenue Reconnection.

For the purposes of the geology and soils analysis, this analysis assumes that the proposed small craft boat launch ramp would require construction of a rubble-mound breakwater (which would be an approximate 420-foot long permanent structure within the turning basin), that the Seaside Lagoon’s existing revetment would require modifications, and that the new pedestrian/bicycle bridge would require two piers within the entrance of Basin 3. In addition,

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9 As described under Section 3.5.3, above, the State of California provides minimum standards for building design through the CBC (Title 24, California Code of Regulations). The CBC is based on the International Building Code (formerly known as the Uniform Building Code), established by the International Code Council (formerly known as the International Council of Building Officials), which is used widely throughout the U.S. (generally adopted on a state-by-state or agency-by-agency basis), and has been modified for conditions within California. Therefore, this analysis assumes compliance with the CBC.
the proposed project includes redevelopment of Basin 3 that includes the replacement of the existing wood docks with concrete docks and modification of the dock configuration, and may possibly require the recapping of, and minor repairs to, the bulkhead. The Pacific Avenue Reconnection and associated changes in pedestrian and bicycle connectivity would require the construction of a retaining wall adjacent to the existing retaining wall along the eastern project boundary with the residential complex. This analysis also assumes that the Sportfishing Pier will be replaced in-kind (in wood or concrete) and that reinforcement of the Horseshoe Pier may be required. These are considered conservative/worst case assumptions because of the type of construction associated with these facilities.

3.5.4.4 Impact Determination

Impact GEO-1: The proposed project would not expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death involving 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, strong seismic ground shaking, or seismic-related ground failure.

As previously discussed, the project site is not located within a State of California Earthquake Fault Zone and there are no mapped faults that underlie the project site; thus, the potential for surface rupture at the project site is considered low. However, the surrounding area, as is most of Southern California, is a seismically active region. Processes influenced by major faults are of primary concern to safe urban development since periodic earthquake activity can be anticipated to continue through the lifetime of buildings constructed today. Thus, ground shaking should be expected during the life of the proposed project. There are a number of faults in the Southern California area that are considered active and could have an effect on the project site in the form of moderate to future strong ground shaking. These faults include, but are not limited to, the Palos Verdes, Redondo-Canyon, Newport-Inglewood, Santa Monica-Raymond, Malibu Coast, and Whittier-Elsinore faults (refer to Table 3.5-1). Given that all of Southern California is subject to seismic events and associated hazards, the potential risk to populations at the project site is not considered to be unique or excessive and would not change the baseline risk for the average visitor to the project site.

The project site, like all of Southern California, is currently subject to seismic hazards. The primary market area associated with the proposed project is the City of Redondo Beach with the secondary market comprising the South Bay (AECOM, 2015). Therefore, a majority of the visitors to the project site are predominantly from Southern California and already subject to the potential risk of seismic hazards; hence, exposure of people or structures to potential adverse effects associated with seismic hazards is not considered unique or excessive and would not change the baseline risk for the average visitor to the project site.

The project site is currently developed and existing on-site soils, which consist primarily of artificial fill. As described in detail in Section 3.5.2.3 and Section 3.4 Cultural Resources of this Draft EIR, the project site has been developed since the late 1800s and is currently occupied by multiple buildings/structures that were constructed between the 1950s and 1980s. Although the original Horseshoe Pier was built in the early 1920s, it has subsequently been rebuilt several times. Most recently, a majority of the pier was destroyed in 1988 from a major storm and subsequent fire, which also destroyed more than 22,000 square feet of leasehold
commercial improvements on the pier. The damaged portions of the pier were subsequently reconstructed with the restored pier opening in 1995.

With the exception of the more modern Kincaid’s building and a restroom/shower building at Seaside Lagoon, the proposed project would replace the older non-compliant buildings/structures throughout the project site with new facilities that comply with current applicable buildings codes. The existing buildings were built from the 1950s to 1980s. Although various building improvements have occurred over the years, these buildings were not constructed to the current and stricter CBC standards. In addition, a majority of the buildings located on the southern section of the Horseshoe Pier are built over the 1928 portion of the pier. In order to redevelop the southern section of the pier, the existing buildings on the southern section would need to be removed to provide the needed access for structural improvements to be made to the pier in compliance with the current load, design and seismic requirements of the CBC. Once the pier has been upgraded to current CBC standards/requirements, buildings would be constructed that would also comply with current building codes.

The Sportfishing Pier’s is in poor condition. Any attempt to repair or replace existing piles was determined to require demolition of a portion of the building and deck to sufficiently expose the bottom and allow equipment to excavate the stone, temporarily set it aside, and replace the pile. Given the number of piles that ultimately need to be repaired or replaced, at least one-half of the building and pier would end up needing to be removed. Therefore, this essentially translates to nearly total demolition and replacement of the existing pier and building. The proposed project includes two options related to the Sportfishing Pier: 1) replacement of the pier and building; and, 2) not replacing the pier and relocating the building square footage into the northern landside development. If replaced, a new pier of similar dimensions would be built in the footprint of the existing pier. In order for the pier to meet current CBC standards/requirements, the entire pier (deck and piles) would be replaced prior to constructing buildings on the pier. Once the pier has been upgraded to current CBC standards/requirements, buildings would be constructed that would also comply with current building codes. If the Sportfishing Pier were not replaced, the 3,415 square feet of development would be relocated into the northern landside development.

The facilities associated with the proposed project would be designed, located, and built in compliance with the most up-to-date building code requirements of the CBC applicable at the time of development. Consequently, the new buildings would offer an improvement in safety related to seismic hazards in comparison to the existing conditions at the project site and impacts would be less than significant.

In addition, the implementation of the proposed project would be required to comply with the recommendations detailed in the approved project-specific geotechnical evaluation(s) and engineering analysis during the design phase, grading plan, and any other relevant reports pertaining to construction criteria and specified seismic parameters. The design- and project-specific geotechnical evaluation(s), engineering analysis and plans submitted to the City’s Building and Safety Division during the design phase would include recommendations and specific conditions that are project site-specific. As part of the Conditional Use Permit process, the City is proposing Conditions of Approval which would require, prior to the issuance of building permits, the City’s Building and Safety Division to incorporate the recommendation and conditions from the design and project-specific geotechnical
evaluation(s),\textsuperscript{10} engineering analysis, and any additional recommendations that come out of this review. The Conditions of Approval would be applied to the implementation of the project through the project plans and the building permit process. The City is proposing the following Conditions of Approval as part of its Conditional Use Permit procedures:

**Conditions of Approval:**

**COA GEO-1: Geotechnical Report Per the Seismic Hazard Mapping Act.**

As required by the Seismic Hazard Mapping Act of 1990 (Public Resources Code Section 2697[a]), the City shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard. Because a majority of the proposed project is within a liquefaction zone, a geotechnical report or reports prepared in accordance with the Act would be prepared and submitted to the City’s Building and Safety Division prior to implementation of the project.

**COA GEO-2: Seismic Design and Engineering Criteria.**

The proposed project would be designed and constructed in accordance with California Building Code provisions associated with seismic design and engineering criteria (including recommendations in geotechnical reports prepared as part of the design process) to minimize potential risks to people and buildings/structures in the event of seismically-induced geological hazards (including liquefaction). This includes requirements for construction, grading, excavations, use of fill, and foundation work (including type of foundation and/or soil improvement requirements), including type of materials, design, procedures, etc. Such design and construction practices would include, but not be limited to, completion of site-specific geotechnical investigations regarding construction and foundation engineering. The design would incorporate measures pertaining to temporary construction conditions as well as long-term operational conditions specific to the project site.

**COA GEO-3: Final Geotechnical Report Review and Approval.**

The final geotechnical report(s) shall be reviewed by the City’s Building and Safety Division for findings and recommendations, and the City shall approve the final project plans once satisfied that all appropriate site-specific design criteria and geotechnical recommendations, including any additional recommendations that come out of this review, have been applied to the implementation of the project through the project plans. The applicant is required to

\textsuperscript{10} Because the project site is within a liquefaction zone, pursuant to Public Resources Code Sections 2690 et seq and 14 California Code of Regulations Sections 3720 et seq, the final geotechnical report(s) for the proposed project would be prepared in compliance with the Seismic Hazard Mapping Act.
comply with the recommendations contained in the geotechnical report.

**Mitigation Measures**

No mitigation is required.

**Residual Impacts**

Impacts would be less than significant.

**Impact GEO-2: The proposed project would not result in substantial soil erosion or the loss of topsoil.**

Although the project site is currently developed, construction of the proposed project would include ground-disturbing activities, such as demolition, excavation, trenching, grading, and landscaping. Approximately 130,000 cubic yards of fill would be required (50,000 cubic yards in the northern portion of the site and 80,000 cubic yards in the southern portion of the site). It is estimated that 45,000 cubic yards of fill would come from on-site concrete debris (20,000 cubic yards would be used in the northern portion of the site, and 25,000 cubic yards would be used in the southern portion of the site). The remaining 85,000 cubic yards of fill required would be imported to the project site (30,000 cubic yards to the northern portion of the site and 55,000 cubic yards to the southern portion). Ground-disturbing activities in general have the potential to expose surficial soils to wind and water erosion and sedimentation, though soil exposure would be temporary and short-term in nature. However, as described in Sections 3.5.3.4 through 3.5.3.6, the project’s construction activities would be required to comply with existing regulatory requirements. This includes implementation of BMP measures and other erosion and sedimentation control measures that would enable project-related grading, excavation, and other earth-moving activities to avoid a significant impact. The proposed project would require implementation of a SWPPP for erosion and sedimentation control. As detailed above in Section 3.5.3.4, the SWPPP is required to include a menu of BMPs to be selected and implemented based on the phase of construction and the weather conditions to effectively control erosion, sediment, and other construction-related pollutants. Erosion control BMPs would be implemented during construction, such as: physical stabilization through hydraulic mulch, soil binders, straw mulch, bonded fiber matrices, and/or erosion control blankets (i.e., rolled erosion control products); soil roughening of graded areas (through track walking, scarifying, sheepfoot rolling, or imprinting) to slow runoff, enhance infiltration, and reduce erosion; dust control through the application of water or other dust palliatives as necessary to prevent and alleviate dust nuisance. Sediment control BMPs during construction would include, as applicable: perimeter protection through silt fences, fiber rolls, gravel bag berms, sand bag barriers, and straw bale barriers; storm drain inlet protection, sediment capture through sediment traps, storm drain inlet protection, and sediment basins; velocity reduction through check dams, sediment basins, and/or outlet protection/velocity dissipation devices; reduction in off-site sediment tracking through stabilized construction entrance/exit, construction road stabilization, and/or entrance/exit tire wash. Implementation of such control measures during construction would prevent substantial soil erosion or the loss of topsoil from exposed soils. After construction is completed, the project site would be covered by paving or landscaping and no large areas of exposed soil that would be exposed to erosion effects of wind or water would remain. Therefore, the proposed improvements would not accelerate wind or water erosion, sedimentation, or off-site sediment deposition. In addition, slope stabilization elements would be designed and constructed as part of project implementation to further reduce the risk of sediment runoff (i.e., sustainable...
erosion control and protection measures). Further, the proposed project would not constitute a
gologic hazard to other properties by destabilizing soils and sediments within the project area
or vicinity. Therefore, potential impacts related to erosion would be less than significant.

Construction activities with coverage under the state CGP would be required to the state’s
requirements related to control of potential erosion and sedimentation. Erosion and sediment
controls would be incorporated into project construction plans, as delineated within the
LSWPPP(s) for site development. The LSWPPP would identify provisions and practices that
include implementation of BMPs during construction activities in order to control erosion and
sedimentation. The LSWPPP would be prepared and submitted to the City prior to the start of
construction, and the control measures would be installed prior to the occurrence of relevant
construction activities as specified in the LSWPPP. Additionally, the amount of soils subject
to erosion would be limited because the site is generally flat and runoff patterns can be easily
controlled by grading and temporary berms and the duration and intensity of rainfall events in
Southern California typically are limited.

Adherence to SCAQMD Rule 403 (Fugitive Dust) would also help to minimize wind erosion
through soil stabilization measures. Table 1 presented in SCAQMD Rule 403 provides
measures for construction activities to reduce fugitive dust. This includes measures for the
application of water or stabilizing agents to prevent generation of dust plumes, pre-watering
materials prior to use, use of tarps to enclose haul trucks, stabilizing sloping surfaces using soil
binders until vegetation or ground cover effectively stabilize slopes, hydroseed prior to rain,
washing mud and soils from equipment at the conclusion of trenching activities (see
SCAQMD Rule 403 Table 1 for additional details). With adherence to Rule 403, the potential
for wind erosion to occur during construction activities would be minimized and impacts
would be less than significant.

As it relates to operation, the project site would be covered by hardscape (e.g., paving and
boardwalks), buildings/structures, or landscaping with no large areas of exposed soil that
would be exposed to erosion effects of wind or water. Further, the proposed recapping of the
bulkheads would reduce erosion.

The proposed project includes the opening of Seaside Lagoon to the adjacent harbor waters,
which could affect erosion of the beach area surrounding the lagoon. This is addressed in
Section 3.8 Hydrology and Water Quality.

The proposed project would not accelerate wind or water erosion from exposed soils during
construction and operation. Therefore, given compliance with existing rules and regulations
and implementation of BMPs and erosion and sedimentation control measures during
construction and operation, potential impacts related to soil erosion or the loss of topsoil
would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.
Impact GEO-3: The proposed project would not result in a significant impact due to on-site or off-site lateral spreading, subsidence, liquefaction, corrosiveness, or collapse due to being located on a geologic unit or soil that is unstable or that would become unstable as a result of the project.

The project site is located in an urbanized coastal area that is relatively flat with a small engineered slope to the east. As analyzed in the NOP/IS (Appendix A of the Draft EIR), according to the State Seismic Hazards Zones map (Redondo Beach 7.5 Minute Quadrangle), the project site is not located within or near an area of previous occurrence of landslide movement. Further, construction work that occurs near the slope to the east would conform with standard engineering requirements such as the CBC (Tile 24, California Code of Regulations), and recommendations, as applicable, in site-specific geotechnical engineering report(s), and would not result in slope instability. Therefore, there would be no impact associated with landslides.

**Liquefaction/Ground Settlement/Lateral Spreading**

As previously described, liquefaction is a temporary, but substantial, loss of shear strength in loose to medium dense, granular solids (e.g., sand, silt, and gravel), and typically occurs where susceptible soils are located below the groundwater table (i.e., shallow groundwater). The lateral spreading hazard would tend to mirror the liquefaction hazard for the project site, and, by definition, needs an open channel or "free" face to expand into, which can include temporary excavations resulting from the construction process. In general, lateral spreading of the ground surface during a seismic activity usually occurs along the weak shear zones within a liquefiable soil layer and has been observed to generally take place toward a free face (e.g., retaining wall, slope, or channel) and, to lesser extent, on ground surfaces with a very gentle slope. Proposed buildings close to the water would be affected to a larger degree by lateral spreading than those further from the water.

As shown in Figure 3.5-4, with the exception of the International Boardwalk, the on-site piers, and the southeast portion, the project site is located within a liquefaction hazard zone due to the combination of shallow groundwater and geologically recent deposits. Because the majority of the project site is located in an area mapped with liquefiable soil, there is potential for seismic-related (earthquake-induced) liquefaction at the project site, which could lead to ground settlement and lateral spreading. As described under Section 3.5.2.2 above, during the 1994 Northridge earthquake, liquefaction and lateral spreading was observed mostly in the area of Mole B, as well as at the Seaside Lagoon. Therefore, existing buildings/structures at the project site are already subject to the potential risk of liquefaction/ground settlement/lateral spreading and the exposure of people or structures to potential adverse effects is not considered unique or excessive. As discussed under Impact GEO-1, the project would result in new buildings/structures on the project site, which would provide safety improvements in comparison to the existing conditions; consequently, impacts would be less than significant.

Based on a ground motion study that determines seismic hazard potential, the predominant earthquake magnitude for the project site is 7.19 with a peak ground acceleration (PGA, expressed in g) equal to 0.537. Although the potential for ground rupture is low, the probability of damage from earthquakes is high. Based on results of a preliminary liquefaction evaluation (refer to Appendix F for details of the evaluation), there is a potential for higher liquefaction settlement within the northern portion of the project site (about eight inches estimated for the upper granular soil) and within the transitional zone that extends into the...
southern portion of the project site. Liquefaction potential of the dense granular soil anticipated in a majority of the southern portion of the site (in particular the area associated with the Pier Plaza and Pier Parking Structure) is relatively low. Although a majority of the project site is within a liquefaction zone, the differences between the liquefaction potential between the northern and southern portions of the site is because of the thickness of the liquefiable deposits, which is due to geologic depositional history (e.g., less thickness of liquefiable deposits in the area of the Pier Parking Structure).

Regardless of the liquefaction/ground settlement/lateral spreading potential at locations throughout the project site, grading, compaction and individual foundations at the proposed project would have to adhere to design- and project-specific standards and requirements of the current CBC. Preliminary analysis indicates that the potential for soil liquefaction (as well as lateral spreading) renders shallow footings infeasible for proposed facilities within the northern portion of the project site and the area of the southern portion of the project site adjacent to Basin 3. There are soil and foundation design options that address the potential for differential movement of the building floor slab due to liquefaction settlement and/or lateral spreading. For instance, it would be necessary to utilize structurally supported building floor slabs in the northern portion of the project site to address the potential for differential movement of the building floor slab due liquefaction settlement and/or lateral spreading. If required, a deep foundation system would include a structurally supported floor slab that would not derive any support from the liquefaction-susceptible soil. The proposed building floor slabs within the southern portion of the project site may be established on existing dense native soil or properly compacted fill material. Thus, it is assumed that the proposed facilities within areas with the potential for soil liquefaction would require deep foundation systems, or alternatively, ground improvement could be performed to alleviate the liquefaction (and lateral spreading) potential. Deep foundation systems could include conventional drilled shafts, driven piling, or alternative systems (e.g., auger cast piles or micropiles). Although not all portions of the project site may require deep foundations systems, for the purposes of the noise, traffic, and air quality analyses it is assumed that, for a conservative analysis, that deep pile foundations are used throughout the site. The placement of the deep pile foundations would occur through either drilled or driven piles, or an alternative system, with drilled piles having potentially comparatively greater noise and vibration levels (as accounted for in Section 3.10 Noise of this Draft EIR) and driven or alternative system piles having comparatively greater generation and off-site disposal of spoils (as accounted for in Section 3.2 Air Quality, and Section 3.13 Traffic and Transportation of this Draft EIR).

In addition, to the foundation requirements discussed in the previous paragraph the proposed project would likely also require improvement of on-site soil conditions to address liquefaction, using the following, or a combination of the following, proven geotechnical engineering technologies:

- **Installation of stone columns.** This option consists of advancing a cylindrical vibratory probe suspended from a crane into the ground. The probe is initially advanced to the required depth of improvement and then withdrawn incrementally to allow the placement of crushed rock to form the stone columns. This methodology would subject the existing buildings and improvements to significant ground vibrations. However, at the time of project construction, a majority of the existing buildings and structures on-site would be demolished. The potential impacts from vibration associated with project construction on adjacent existing buildings are evaluated in Section 3.10 Noise of this Draft EIR.
• **Compaction grouting.** This option is a high-pressure technique that consists of the injection of a very stiff, mortar-like grout into the soil, which results in densification of granular soil and increased stiffness in fine-grained soil. This improvement would be accomplished without excessive vibrations at the project site and would allow the use of shallow foundations to support the proposed facilities.

• **Soil-cement mixing.** This option consists of the injection of water and cement into the soil matrix, typically using a crane-mounted rig equipped with drill rods with paddles welded at varying depths, essentially like a kitchen-mixer. The soil cement mixture cures to form relatively stiff columns within the soil matrix, and a grid pattern of soil-cement columns is established to reinforce the soil. It would be used to construct gravity-type walls that could resist lateral spreading. Soil-cement mixing would result in spoils that require off-site disposal, which is evaluated in Section 3.2 Air Quality, of this Draft EIR.

Determination of the appropriate option, or combination of options, to address liquefaction would be determined through the review of project-specific geotechnical evaluations and supplemental engineering analysis in compliance with CBC requirements and subsequent recommendations based on City review. Because geologic conditions can vary across the project site, the subsequent geotechnical evaluations and supplemental engineering analysis would be performed and finalized once the individual building designs are known. While the proposed project would offer improvements in comparison to the existing conditions on the project site, the City is proposing Conditions of Approval COA GEO-2 and COA GEO-3, detailed under Impact GEO-1 above, as part of its Conditional Use Permit procedures.

**Subsidence**

The degree of earthquake-induced ground subsidence for unsaturated sands was estimated. Seismic shaking-induced ground subsidence of approximately three to six inches may occur within existing soil due to the placement and compaction of new fill soil. The seismic settlement in unsaturated dry soil is considered minimal and settlement negligible since the groundwater level at the project site is high. Therefore, subsidence hazards are not likely and impacts would be less than significant.

**Collapse**

Collapsible soils tend to be young soils that have been rapidly deposited and occur in arid and semiarid areas. However, the project site has previously been developed and existing on-site soils consist of artificial fill. The proposed project would replace these older non-compliant buildings/structures with new facilities, which comply with current applicable building codes (described above). Potential for impacts related to collapse would therefore be less than significant.

**Corrosive Soils**

In general, corrosive soils are fine-grained soils (soil with smaller particle size) that results in greater surface area with high chemical and moisture affinity. As with liquefaction/ground settlement/lateral spreading, regardless of the potential for corrosive soils at the project site, the proposed project would have to adhere to design- and project-specific standards and requirements of the current CBC. As discussed under Impact GEO-1, the proposed project would result in new buildings/structures on the project site, which would comply with current applicable building codes and provide safety improvements in comparison to the existing
conditions; consequently, potential for impacts related to corrosive soils would be less than significant.

The design- and project-specific geotechnical evaluation(s), engineering analysis and plans submitted to the City’s Building and Safety Division during the design phase would include recommendations and specific conditions that are project site-specific. Furthermore, as part of the Conditional Use Permit process, the City is proposing Conditions of Approval, described above, which would require, prior to the issuance of building permits, the City’s Building and Safety Division to approve the recommendation and conditions from the design and project-specific geotechnical evaluation(s), engineering analysis, compliance with the CBC, and any additional recommendations that come out of this review, be applied to the implementation of the project through the project plans. The resulting final geotechnical engineering recommendations and any additional recommendations that come out of this review, would be incorporated into the project’s final design plans to address seismic safety standards and practices, including subsidence, present in the project site. Therefore, with applicable design standards and current CBC requirements, the proposed project would not result in an on-site or off-site lateral spreading, subsidence, liquefaction, corrosiveness, or collapse due to being located on a geologic unit or soil that is unstable or that would become unstable as a result of the project. Impacts associated with potential for unstable soils would be less than significant.

Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

Impact GEO-4: The proposed project would not create substantial risks to life or property due to the presence of expansive soil, as defined in the California Building Code.

Expansive soils generally result from specific clay minerals that expand when saturated and shrink in volume when dry, resulting in a change in the soil volume. Expansive soils beneath proposed building foundations could result in cracking and distress of foundations, or otherwise damage buildings/structures built on these sediments. The existing on-site geologic deposits and artificial fill consists mostly of sand/silty sand; therefore, the soils at the project site would not likely be expansive. There is clayey soil below groundwater at the project site; however, this clayey soil is fully submerged and would not create a risk and impacts would be less than significant.

Mass grading would occur throughout the project site. This work is expected to include the placement of new fill and the removal and re-compaction of unsuitable soil and backfill for utility trenches and other excavations. Likewise, the removal, re-compaction, and/or placement of new fill would occur based on a design- and project-specific evaluation of the expansion potential associated with on-site soils. It would include subsurface soil sampling, laboratory analysis of samples collected, and an evaluation of the laboratory testing results by a geotechnical engineer. Resulting recommendations would be incorporated into the project’s final design plans to address expansive soils and would translate into Conditions of Approval, as part of the Conditional Use Permit process. These recommendations and approvals would be customized as appropriate for the various types of buildings/structures proposed.
Mitigation Measures

No mitigation is required.

Residual Impacts

Impacts would be less than significant.

3.5.4.5 Cumulative Impacts

Geologic hazard impacts, such as fault rupture, ground shaking, lateral spreading, subsidence, and liquefaction tend to be location-specific and do not compound or increase in combination with past, present or future projects. Any future development within the geographic scope of the City (i.e., the boundary of the City) would encounter geologic and seismic risks based on their individual site constraints.

Notwithstanding, the cumulative impact analysis provided herein considers the anticipated population growth within the City. For the most part, the City is built out and its population is expected to increase by 0.36 percent per SCAG projections. The cumulative population would continue to be exposed to seismic and geologic hazards because the City is located within a seismically-active region. The coastal areas of the City consist of historic occurrence of liquefaction. The closest earthquake fault zone—Newport-Inglewood—is located approximately four miles from the City boundary. Impacts associated with the exposure of that future increased population in the City to the existing regional seismic activity risk may differ in terms of increased population occurring within new development that meets current seismic safety design requirements and increased population occurring within older existing developments that are not designed/constructed for seismic safety. In the case of the former, potential impacts related to seismic and other geologic conditions would be addressed by implementation and enforcement of the local grading ordinance; compliance with building code standards; structural regulations adopted and enforced by the City; and public safety policies and programs adopted by the City.

Implementation of the proposed project would not result in a cumulatively considerable contribution to impacts relative to seismic hazards (i.e., fault rupture, ground shaking, liquefaction, lateral spreading, and subsidence); substantial soil erosion or loss of topsoil; geologic unit or soil that is unstable or that would become unstable; and expansive and corrosive soils.

Cumulative Mitigation Measures

No mitigation is required.

Cumulative Residual Impacts

Impacts would be less than significant.

3.5.4.6 Summary of Impact Determinations

The following Table 3.5-2 summarizes the impact determinations of the proposed project and proposed project in addition to adopted growth projections (i.e., potential cumulative impacts) related to geology and soils, as described in the detailed discussion above.
Table 3.5-2: Summary Matrix of Potential Impacts and Mitigation Measures for Geology and Soils Associated with the Proposed Project and Cumulative Growth

<table>
<thead>
<tr>
<th>Environmental Impacts</th>
<th>Impact Determination</th>
<th>Mitigation Measures</th>
<th>Impacts after Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEO-1: The proposed project would not expose people or structures to potential substantial adverse effects including the risk of loss, injury, or death involving 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, strong seismic ground shaking, or seismic-related ground failure, including liquefaction.</td>
<td>Proposed Project: Less than significant</td>
<td>Proposed Project: No mitigation is required</td>
<td>Proposed Project: Less than significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cumulative: Less than significant (no cumulatively considerable contribution)</td>
<td>Cumulative: No mitigation is required</td>
</tr>
<tr>
<td>GEO-2: The proposed project would not result in substantial soil erosion or the loss of topsoil.</td>
<td>Proposed Project: Less than significant</td>
<td>Proposed Project: No mitigation is required</td>
<td>Proposed Project: Less than significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cumulative: Less than significant (no cumulatively considerable contribution)</td>
<td>Cumulative: No mitigation is required</td>
</tr>
<tr>
<td>GEO-3: The proposed project would not result in a significant impact due to on-site or off-site lateral spreading, subsidence, liquefaction, corrosiveness, or collapse due to being located on a geologic unit or soil that is unstable or that would become unstable as a result of the project.</td>
<td>Proposed Project: Less than significant</td>
<td>Proposed Project: No mitigation is required</td>
<td>Proposed Project: Less than significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cumulative: Less than significant (no cumulatively considerable contribution)</td>
<td>Cumulative: No mitigation is required</td>
</tr>
<tr>
<td>GEO-4: The proposed project would not create substantial risks to life or property due to the presence of expansive soil, as defined in the California Building Code.</td>
<td>Proposed Project: Less than significant</td>
<td>Proposed Project: No mitigation is required</td>
<td>Proposed Project: Less than significant</td>
</tr>
<tr>
<td></td>
<td></td>
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<tbody>
<tr>
<td></td>
<td>considerable contribution)</td>
<td></td>
<td>cumulatively considerable)</td>
</tr>
</tbody>
</table>

### 3.5.4.7 Summary of Mitigation Measures

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

### 3.5.5 Significant Unavoidable Impacts

No significant unavoidable impacts to geology and soils would occur as a result of construction or operation of the proposed project.