3.5 Geology, Seismicity, and Soils

3.5.1 Introduction

This section evaluates the potential for the proposed project to result in adverse impacts related to geologic, seismic, and soils hazards. The analysis is based on review of available geologic and geotechnical reports and maps of the project area and vicinity, including site-specific investigations conducted for each of the four individual sites that comprise the proposed project, the relevant regulatory ordinances, and a discussion of the methodology and thresholds used to determine whether the proposed project would result in significant impacts. This section analyzes the potential for both project-level and cumulative environmental impacts.

Data used in this section includes information obtained from the geotechnical studies prepared for the project site (KCG 2016a [Appendix E1], 2016b [Appendix E2], 2015c [Appendix E3]), Phase I and II environmental site assessments prepared for the project site (CH2MHill 2004; Rincon 2015a [Appendix F1], Rincon 2015b [Appendix F2]; AEC 2016a [Appendix F3], 2016b [Appendix F4], 2016c [Appendix E4]), white papers describing the operation of the project (BOMP 2017a [Appendix E5], 2017b [Appendix E6], 2017c [Appendix E7]), the Low Impact Development Plan (LID Plan) for the proposed project (Wilson Mikami 2017 [Appendix G2]), an engineering study for the relocation of oil pipelines (Honneger 2016 [Appendix E8]), and the Seismic Safety (City of Long Beach 1988) and Public Safety (City of Long Beach 1975) elements of the City of Long Beach General Plan. All information sources used are included as citations within the text; sources are listed in Section 3.5.5, References.

3.5.2 Environmental Setting

3.5.2.1 Existing Land Uses, Topography, and Drainage

Figure 2-1, Regional Location, and Figure 2-2, Project Site and Local Vicinity, in Chapter 2, Project Description, show the locations of the four individual sites that comprise the proposed project. The four individual sites are located within the Seal Beach Oil Field, an oil producing area with numerous producing oil wells. The production, idle, and plugged wells on the four individual sites are summarized in Table 2-1, Oil Wells by Site, and shown in Figure 2-3, Existing Oil Wells on the Project Site, in Chapter 2, Project Description. The regional area of the project site was once a tidal salt marsh; consequentially, the topography of the project area is relatively flat. Regionally, the topography surrounding the project site gradually slopes to the southwest; however, local drainage on the individual sites can vary. For example, the drainage on the LCWA site is to the north and east (KCG 2016b). A discussion of the drainage for each site is provided in Section 3.8, Hydrology and Water Quality. The San Gabriel River runs along the southern boundaries of the City Property site and the Pumpkin Patch site. The Los Cerritos Channel lies to the north of the Synergy Oil Field site. The Steamshovel Slough runs east to west through the northern portion of the Synergy Oil Field site.

The Synergy Oil Field site consists of approximately 150 acres at elevations of 6 to 12 feet above mean sea level (amsl). The Synergy Oil Field site is developed with the single-story Synergy office building; 39 active and idle wells; and supporting production infrastructure, such as tank farms and pipelines (KCG 2016c). The City Property site is also an active oil field with 13 active and idle wells; pipelines; and supporting oil infrastructure on land that consists of a mix of wetland and degraded wetland habitat, and disturbed areas occupied by active oil production. The Pumpkin Patch site consists of approximately 7 acres with elevations of about 18 feet amsl, and...
one active well (KCG 2016a). The Pumpkin Patch site is also currently used seasonally for the sale of pumpkins and Christmas trees. The LCWA site consists of approximately 5 acres at about 15 feet above mean sea level of undeveloped land used on a temporary lease basis for equipment storage and staging (KCG 2016b).

### 3.5.2.2 Regional and Local Geology

#### Regional Geology

The project site is located in the Peninsular geomorphic province\(^{38}\) that includes the Los Angeles Basin characterized by a series of mountain ranges separated by long valleys, formed from faults branching from the San Andreas Fault. Past research suggests that over the past 20,000 years, the Rio Hondo, San Gabriel, and Santa Ana Rivers have moved back and forth across the coastal flood plains in Los Angeles and Orange County, depositing geologically recent alluvial materials (KCG 2016a). The coastal portion of the floodplain is bound by a line of elongated folded low hills and faults. This portion of the basin is dominated by the northwest-trending Newport-Inglewood Structural Zone, which diagonally crosses the Synergy Oil Field and City Property sites as the Newport-Inglewood Fault Zone shown in Figure 3.5-1, Regional Faults, and Figure 3.5-2, Newport-Inglewood Fault Zone.

The project site totals approximately 195 acres of developed and disturbed land in the southeastern portion of the City of Long Beach (City). The topography of the Long Beach area is generally flat with elevations of less than 100 feet; however, geologic uplifts have occurred, which have interrupted the plain in different areas and resulted in prominent folds and hills. These distinguishable uplifts are oriented in a northwest-southeast direction, along the Newport-Inglewood Fault Zone, shown crossing the Synergy Oil Field and City Property sites shown in Figure 3.5-2 (City of Long Beach 1973).

#### Local Geology

The soil on and underlying each of the four individual sites that comprise the project site consists of artificial fill associated with past land use and younger alluvial deposits. The underlying younger alluvial deposits in the area consist of Holocene (present to 11,000 years ago) alluvial silty sand, sandy silt, sand, and some clayey silt to depths of over 1,000 feet in some localities (Rincon 2015a, 2015b). Artificial fill at the sites consists of modern surficial deposits of fill resulting from human construction, landfills, reclamation, or oil and gas production activities, which includes engineered and non-engineered fill. Details of landfill materials, where known, are discussed below by site.

#### Closed Landfill on Synergy Oil Field Site

During the 1960s, a northeast portion of the Synergy Oil Field site was used as a municipal landfill identified as the Studebaker/Loynes Disposal Site or City Dump and Salvage #4 (Rincon 2015a, 2015b). This landfill is no longer operational, and has a closed status as of mid-April 1980. This landfill was located on a narrow strip in the northeastern portion of the Synergy Oil Field as shown in Figure 3.5-3, Landfill Areas on Synergy Oil Field Site, and extended off site to the north. The landfill waste included approximately 160,000 cubic yards of waste materials consisting of household and commercial refuse, inert solid materials, and street sweepings, placed in a previously existing depression area, compacted, and covered with clean soil in conformance with slope and final cover requirements. The maximum depth to refuse is estimated to be up to 25 feet.

\(^{38}\) A geomorphic province is an area that possesses similar bedrock, structure, history, and age. California has 11 geomorphic provinces (CGS 2002).
Figure 3.5-1
Regional Faults

SOURCE: ESRI; USGS 2009

Long Beach Cerritos Wetland. 150712
Figure 3.5-2

Newport-Inglewood Fault Zone

SOURCE: ESRI; City of Long Beach 2015; California Department of Conservation 2001
Figure 3.5-3

Landfill Areas on Synergy Oil Field Site
In addition, the former LA County Flood Control Dump may have extended onto the southwestern corner of the Synergy Oil Field site, as shown in Figure 3.5-3. The records are unclear as to its precise location, extent, or depth. This landfill was reportedly used to dispose of vegetation growing along the banks of the San Gabriel River. The location of the fill does not extend as far east as the proposed location for the visitors center.

**Closed Landfill on Pumpkin Patch Site**

The Pumpkin Patch site was previously operated as the City Dump and Salvage Landfill #2 in the western two-thirds of the site (AEC 2016a, 2016c; KCG 2016a). The extent of the landfilled materials is shown in Figure 3.5-4, Landfill Area and Monitoring Wells on Pumpkin Patch Site. In September 1960, City Dump and Salvage received a permit from the County of Los Angeles, Industrial Waste Division, to accept household and construction waste at a minimum of at least 300 feet from Pacific Coast Highway. The permit allowed the landfill to accept non-water soluble, non-decomposable inert solids, ordinary household and commercial refuse, including decomposable organic refuse and scrap metal, and garbage and market refuse. The landfill commenced waste acceptance operations at the site in mid-1960 and ceased operations in early 1961 after filling the “trench” landfill to its permitted capacity. The disposal permit allowed for the excavation of a trench to below the groundwater table and the subsequent filling with refuse. Final cover of the landfill was completed by May 16, 1961.

Various investigations have been conducted beginning in 1987 to delineate the extent of the landfill, and to characterize the nature and extent of chemicals associated with both the landfill and the oil production. The combined investigations indicate the landfill is rectangular, encompasses the eastern half of the site, and that the refuse in the central portion of the burial area extends to a depth of 30 feet below ground surface (bgs). The refuse in the landfill consists of newspaper, plastic, metal, wood, glass, plant debris, rubber tubes and tires, and green waste.

**LCWA Site Fill**

Reportedly, approximately 20 feet of fill soil was brought in over a long time period previous to 1973 to bring this former marshy area to its current grade (AEC 2016b). A previous 2004 Phase II report cited in AEC 2016b described an area in the central-western portion of the LCWA site as a “debris pit” previously used for dumping waste cement and asphalt debris prior to 2004 (CH2MHIll 2004). The areal extent of the pit is uncertain. During the Phase II investigation, a solid-stem auger dropped approximately 5 feet in an area where the buried concrete debris had created a void space. A visual inspection inside the annular space indicated a small cavern in the shallow subsurface. Based on the site history, the top 20 feet of the entire parcel may consist of imported soil and debris.

**City Property Site**

The Phase I assessment indicated the City Property site is covered with fill materials and modern surficial deposits (Rincon 2015b); however, specific details about the nature and depth of the fill materials or native soils are undocumented. None of the nearby documented landfills are known to extend onto the City Property site.
Figure 3.5-4
Landfill Area and Monitoring Wells on Pumpkin Patch Site

SOURCE: Withee Malcolm Architects, LLP
3.5.2.3  Seismicity and Faults

This section characterizes the region’s existing faults, describes historical earthquakes, estimates the likelihood of future earthquakes, and describes probable groundshaking effects.

**Earthquake Terminology and Concepts**

**Earthquake Mechanisms and Fault Activity**

Faults are planar features within the earth’s crust that have formed to release strain caused by the dynamic movements of the earth’s major tectonic plates. An earthquake on a fault is produced when these strains overcome the inherent strength of the earth’s crust, and the rock ruptures. The rupture causes seismic waves that propagate through the earth’s crust, producing the groundshaking effect known as an earthquake. The rupture also causes variable amounts of slip along the fault, which may or may not be visible at the earth’s surface.

Geologists commonly use the age of offset rocks as evidence of fault activity—the younger the displaced rocks, the more recently earthquakes have occurred. To evaluate the likelihood that a fault would produce an earthquake, geologists examine the magnitude and frequency of recorded earthquakes and evidence of past displacement along a fault. The California Geological Survey (CGS) defines an active fault as one that has had surface displacement within Holocene time (within the last 11,000 years; the U.S. Geological Survey [USGS] uses within the last 15,000 years). A Quaternary fault is defined as a fault that has shown evidence of surface displacement during the Quaternary period (the last 1.6 million years), unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not mean that a fault lacking evidence of surface displacement is necessarily inactive. The term “sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement has occurred on one or more of its segments or branches (CGS 2007).

For the purpose of delineating fault rupture zones, the CGS historically sought to zone faults defined as potentially active, which are faults that have shown evidence of surface displacement during the Quaternary period (the last 1.6 million years). In late 1975, the State Geologist made a policy decision to zone only those faults that had a relatively high potential for ground rupture, determining that a fault should be considered for zoning only if it was sufficiently active and “well defined.” Blind faults are faults that do not show surface evidence of past displacement, even if they occurred in the recent past; and faults that are confined to pre-Quaternary rocks (more than 1.6 million years old) are considered inactive and incapable of generating an earthquake.

**Earthquake Magnitude**

When an earthquake occurs along a fault, its size can be determined by measuring the energy released during the event. A network of seismographs records the amplitude and frequency of the seismic waves that an earthquake generates. The Richter magnitude (ML) of an earthquake represents the highest amplitude measured by the seismograph at a distance of 100 kilometers from the epicenter. Richter magnitudes vary logarithmically with each whole-number step, representing a tenfold increase in the amplitude of the recorded seismic waves and 32 times the amount of energy released. While Richter magnitude was historically the primary measure of earthquake magnitude, seismologists now use Moment Magnitude (Mw) as the preferred way to express the size of an earthquake. The Mw scale is related to the physical characteristics of a fault, including the rigidity of the rock, the size of fault rupture, and the style of movement or displacement across faults.
the fault. Although the formulae of the scales are different, they both contain a similar continuum of magnitude values, except that Mw can reliably measure larger earthquakes and do so from greater distances.

**Peak Ground Acceleration**

A common measure of ground motion at any particular site during an earthquake is the peak ground acceleration (PGA). The PGA for a given component of motion is the largest value of horizontal acceleration obtained from a seismograph. PGA is expressed as the percentage of the acceleration due to gravity (g), which is approximately 980 centimeters per second squared. In terms of automobile acceleration, one “g” of acceleration is equivalent to the motion of a car traveling 328 feet from rest in 4.5 seconds. For comparison purposes, the maximum PGA value recorded during the 1994 Northridge earthquake in the vicinity of the epicenter exceeded 1 g in several areas. Unlike measures of magnitude, which provide a single measure of earthquake energy, PGA varies from place to place and is dependent on the distance from the epicenter and the character of the underlying geology (e.g., hard bedrock, soft sediments, or artificial fills).

**Modified Mercalli Intensity Scale**

The Modified Mercalli Intensity Scale assigns an intensity value based on the observed effects of groundshaking produced by an earthquake. Unlike measures of earthquake magnitude and PGA, the Modified Mercalli Intensity Scale is qualitative in nature in that it is based on actual observed effects rather than measured values. Similar to PGA, Modified Mercalli values for an earthquake at any one place can vary depending on the earthquake’s magnitude, the distance from its epicenter, the focus of its energy, and the type of geologic material. The Modified Mercalli values for intensity range from I (earthquake not felt) to XII (damage nearly total), and intensities ranging from IV to X can cause moderate to significant structural damage. Because the Modified Mercalli scale is a measure of groundshaking effects, intensity values can be correlated to a range of average PGA values, as shown in Table 3.5-1, Modified Mercalli Intensity Scale.

**Faults and Historical Earthquake Activity**

The project area is located in a seismically active region of California. The Los Angeles Basin contains both active (Holocene-age within the last 11,000 years) and potentially active (Quaternary-age, or within the last 1.6 million years) faults. Throughout the project area, there is the potential for damage resulting from movement along any one of a number of the active faults. The Working Group on California Earthquake Probabilities (WGCEP), comprised of the USGS, the CGS, and the Southern California Earthquake Center, evaluates the probability of one or more earthquakes of Mw 6.7 or higher occurring in the state of California over the next 30 years. It is estimated that the Los Angeles region areas as a whole has a 60 percent chance of experiencing an earthquake of Mw 6.7 or higher over the next 30 years; among the various active faults in the region, the southern San Andreas Fault is the most likely to cause such an event (WGCEP 2015).

Several active and potentially active faults have been mapped within or close to the project area. The approximate locations of the major faults in the region and their geographic relationship to the project area region are shown in Figure 3.5-1. The closer view of the Newport-Inglewood Fault Zone, which diagonally crosses the Synergy Oil Field and City Property sites, is shown in Figure 3.5-2.
### Table 3.5-1 Modified Mercalli Intensity Scale

<table>
<thead>
<tr>
<th>Intensity Value</th>
<th>Intensity Description</th>
<th>Average Peak Ground Acceleration$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Not felt</td>
<td>&lt; 0.0017 g</td>
</tr>
<tr>
<td>II</td>
<td>Felt by people sitting or on upper floors of buildings</td>
<td>0.0017 to 0.014 g</td>
</tr>
<tr>
<td>III</td>
<td>Felt by almost all indoors. Hanging objects swing. Vibration like passing of light trucks. May not be recognized as an earthquake.</td>
<td>0.0017 to 0.014 g</td>
</tr>
<tr>
<td>IV</td>
<td>Vibration felt like passing of heavy trucks. Stopped cars rock. Hanging objects swing. Windows, dishes, doors rattle. Glasses clink. In the upper range of IV, wooden walls and frames creak.</td>
<td>0.014 to 0.039 g</td>
</tr>
<tr>
<td>V (Light)</td>
<td>Felt outdoors. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing. Pictures move. Pendulum clocks stop.</td>
<td>0.035 to 0.092 g</td>
</tr>
<tr>
<td>VI (Moderate)</td>
<td>Felt by all. People walk unsteadily. Many frightened. Windows crack. Dishes, glassware, knickknacks, and books fall off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster, adobe buildings, and some poorly built masonry buildings cracked. Trees and bushes shake visibly.</td>
<td>0.092 to 0.18 g</td>
</tr>
<tr>
<td>VII (Strong)</td>
<td>Difficult to stand or walk. Noticed by drivers of cars. Furniture broken. Damage to poorly built masonry buildings. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and porches. Some cracks in better masonry buildings. Waves on ponds.</td>
<td>0.18 to 0.34 g</td>
</tr>
<tr>
<td>VIII (Very Strong)</td>
<td>Steering of cars affected. Extensive damage to unreinforced masonry buildings, including partial collapse. Fall of some masonry walls. Twisting, falling of chimneys and monuments. Wood-frame houses moved on foundations if not bolted; loose partition walls thrown out. Tree branches broken.</td>
<td>0.34 to 0.65 g</td>
</tr>
<tr>
<td>IX (Violent)</td>
<td>General panic. Damage to masonry buildings ranges from collapse to serious damage unless modern design. Wood-frame structures rack, and, if not bolted, shifted off foundations. Underground pipes broken.</td>
<td>0.65 to 1.24 g</td>
</tr>
<tr>
<td>X (Very Violent)</td>
<td>Poorly built structures destroyed with their foundations. Even some well-built wooden structures and bridges heavily damaged and needing replacement. Water thrown on banks of canals, rivers, lakes, etc.</td>
<td>&gt; 1.24 g</td>
</tr>
<tr>
<td>XI (Very Violent)</td>
<td>Few, if any, masonry structures remain standing. Bridges destroyed. Rails bent greatly. Underground pipelines completely out of service.</td>
<td>&gt; 1.24 g</td>
</tr>
<tr>
<td>XII (Very Violent)</td>
<td>Damage nearly total. Practically all works of construction are damaged greatly or destroyed. Large rock masses displaced. Waves seen on ground surface. Lines of sight and level are distorted. Objects are thrown into the air.</td>
<td>&gt; 1.24 g</td>
</tr>
</tbody>
</table>

**SOURCES:** ABAG, 2016; CGS, 2003.

**NOTES:**

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

### Regional Faults

#### San Andreas Fault Zone

The San Andreas Fault Zone is a major structural feature in the region and forms a boundary between the North American and Pacific tectonic plates (Bryant and Lundberg 2002). The San Andreas Fault is a major northwest-trending, right-lateral,$^{40}$ strike-slip$^{41}$ fault. The fault extends for about 600 miles from the Gulf of California in the south to Cape Mendocino in the north. The San Andreas is not a single fault trace but rather a system of active faults that diverges from the main fault south of the city of San Jose, California. The San Andreas Fault has produced numerous large earthquakes, including the 1906 San Francisco earthquake. That event had an estimated ML 8.3 or Mw 7.8 (WGCEP 2008a, 2008b) and was associated with up to 21 feet of

---

$^{40}$ To an observer straddling a right-lateral fault, the right-hand block or plate would move towards the observer.

$^{41}$ A strike-slip fault creates vertical (or nearly vertical) fractures (i.e., the blocks primarily move horizontally).
displacement and widespread ground failure (Lawson 1908). The San Andreas Fault Zone has a 19 percent probability of generating an earthquake in the Southern California region with a magnitude equal to or greater than 6.7 Mw over the next 30 years (WGCEP 2015). The San Andreas Fault is located approximately 50 miles northwest of the project site.

**Whittier Fault Zone**

The Whittier Fault is approximately 25 miles in length; its nearest communities are Yorba Linda, Hacienda Heights and Whittier (Caltech 2016a). The Whittier Fault has a 1.29 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 Mw over the next 30 years (WGCEP 2015). The Whittier Fault is approximately 15 miles from the project site.

**Compton Fault Zone**

The Compton Fault is a large, concealed blind thrust fault that extends northwest-southeast for approximately 25 miles beneath the western edge of the Los Angeles metropolitan region. Unlike most faults, which rupture to the surface in large earthquakes, near-surface deformation above blind thrust faults is accommodated by folding, rather than faulting. The Compton Fault is active and has generated at least six large-magnitude earthquakes (Mw 7.0 to 7.4) during the past 14,000 years (Leon et al. 2009). The Compton Fault has a 0.60 to 0.67 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 over the next 30 years (WGCEP 2015). The Compton Fault is located approximately 2.5 miles southwest of the project site.

**Puente Hills Fault Zone**

The Puente Hills Fault is a blind thrust fault extending more than 25 miles in the northern Los Angeles Basin from downtown Los Angeles east to Brea in northern Orange County. The fault consists of three distinct geometric segments: Los Angeles, Santa Fe Springs, and Coyote Hills. The Puente Hills Fault generated the 1987 Mw 6.0 Whittier Narrows earthquake southeast of Los Angeles (Shaw et al. 2002). Subsections 1 and 0 of the Puente Hills Fault have a 0.95 to 0.96 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 over the next 30 years (WGCEP 2015). The Puente Hills fault is located approximately 12 miles north of the project site.

**Palos Verdes Fault Zone**

The Palos Verdes Fault is approximately 50 miles in length and has two main branches: the Cabrillo Fault and the Redondo Canyon Fault. The Palos Verdes Fault passes through the cities of San Pedro, Palos Verdes Estates, Torrance and Redondo Beach (Caltech 2016b), and is located approximately 9 miles southwest of the project site. The Palos Verdes Fault has a 3.03 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 over the next 30 years (WGCEP 2015).

**Los Alamitos Fault**

The Los Alamitos Fault, more recently called the Compton-Los Alamitos Fault is located about 3 miles north of the project site. Recent research on the Compton-Los Alamitos Fault concluded that some movement occurred during the 1933 Long Beach earthquake, meaning that this fault is considered active (Yeats and Verdugo 2010). Earthquake probabilities have not yet been estimated.
Local Faults

In addition to being shown in Figure 3.5-1, the local fault’s location in relation to the four locations is shown in detail in Figure 3.5-2.

Newport-Inglewood Fault Zone

The Newport-Inglewood Fault is northwest-trending and dominates the geologic structure of the coast line from Newport Beach to north of the Long Beach area. As a result of the fault movement in the area, a number of elongated hills are present in the area including the Dominguez Hills and Signal Hill. The 1933 Mw 6.4 Long Beach earthquake occurred along the Newport-Inglewood fault offshore from Huntington Beach (KCG 2016a). Both the Synergy Oil Field and City sites are bisected by the Newport-Inglewood Fault (KCG 2015c; Honegger 2016). The Pumpkin Patch site is approximately 1,000 feet southwest of the Newport-Inglewood fault zone; the LCWA site is 200 feet northeast of the fault zone (KCG 2016a, 2016b). The fault has a 0.71 to 0.95 percent probability of generating an earthquake with a magnitude equal to or greater than 6.7 over the next 30 years (WGCEP 2015).

3.5.2.4 Geologic Hazards

Based on the geologic data reviewed during preparation of this EIR, the potential geologic hazards at the proposed project site include erosion, subsidence, and expansive soil. These geologic hazards are discussed below. Liquefaction, landslides, and lateral spreading, while possible without seismic shaking, are more commonly triggered by a seismic event, as discussed further below in seismic hazards.

Erosion

Erosion is the wearing away of soil and rock by processes such as mechanical or chemical weathering, mass wasting, and the action of water and wind. Excessive soil erosion can eventually damage infrastructure such as pipelines, wellheads, building foundations, and roadways. In general, granular soils with relatively low cohesion and soils located on steep topography have a higher potential for erosion.

As previously discussed, all four individual sites that comprise the project site have relatively flat topographies, resulting in a relatively low potential for soil erosion. In addition, erosion potential is typically further reduced or eliminated once the soil is graded and covered with hardscape or vegetation, or other slope protection measures, including habitat restoration.

Subsidence

When oil and/or groundwater is extracted from the subsurface, subsidence of the overlying land surface can occur. This type of subsidence is usually associated with severe, long-term withdrawal in excess of recharge that eventually leads to overdraft of the aquifer. As oil and/or groundwater is pumped out, water and/or oil is removed from the soil pore spaces leading to a reduction in soil strength. The subsurface conditions more conducive to subsidence include clay or organic-rich soils. Sand- and gravel-rich soils are less prone to subsidence because the larger grains comprise a skeleton less dependent on water pressure for support. The subsidence can result in damage to infrastructure such as buildings or pipelines, or can result in a decrease in the volume of available aquifer storage. This is the reason the produced water pumped from the subsurface along with oil production is purposely injected back into the same depth interval to prevent subsidence.
In the area of the four individual sites that comprise the project site, historical subsidence was previously associated with oil production and the groundwater pumped out along with the oil. Generally, subsidence in the Long Beach area was concentrated in the Long Beach Harbor area (Wilmington oil field, located south and west of the project site area) and lessened with distance away from the Wilmington area. It has been estimated that north and east of the main Long Beach Harbor area, this subsidence averaged a few tenths of a foot over a period of about 20 years and was generally uniform across wide areas (KCG 2016b). As previously noted, the injection of produced water back into oil production zones has arrested regional subsidence.

However, there is the potential for subsidence on former landfill areas. There are landfilled areas on the Synergy Oil Field, Pumpkin Patch, and LCWA sites. The degree of compaction at the Synergy Oil Field and Pumpkin Patch sites are unknown. The landfill area is in the northeast portion of the Synergy Oil Field site. The landfilled area on the Pumpkin Patch and LCWA sites are in the central portion of the sites. Because of the unknown level of compaction of the fill at the former landfill and shallow groundwater table at the Pumpkin Patch site, potential site-specific subsidence risks are considered to be moderate to high (KCG 2016a). The geotechnical study conducted at the LCWA site concluded that continued subsidence potential risks are considered to be low (KCG 2016b).

**Expansive Soils**

Expansive soils are subject to volume changes from changes in moisture content: swelling with increases in moisture; shrinkage with decreases in moisture. Based on visual observation of the Pumpkin Patch and LCWA sites, it appears that minor amounts of fine grained materials are interspersed throughout the alluvial soil. This creates the possibility for soils with higher expansion potential to exist near the surface due to mixing of soils during grading; however, the geotechnical investigation of the alluvial materials on the Pumpkin Patch site and LCWA site concluded that the materials have a low to moderate expansion potential (KCG 2016a, 2016b). It is assumed this condition also applies to the Synergy Oil Field and City Property sites.

**3.5.2.5 Seismic Hazards**

Seismic hazards are generally classified into two categories: primary seismic hazards (surface fault rupture and groundshaking) and secondary seismic hazards (liquefaction and other types of seismically induced ground failure, along with seismically induced landslides).

**Surface Fault Rupture**

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake’s seismic waves. The magnitude, sense, and nature of fault rupture can vary for different faults or even along different strands of the same fault. Although future earthquakes could occur anywhere along the length of an active fault, only regional strike-slip earthquakes of magnitude 6.0 or greater are likely to be associated with significant surface fault rupture and offset (CDMG and USGS 1996). It is also important to note that unmapped subsurface fault traces could experience unexpected and unpredictable earthquake activity and fault rupture.

The highest potential for surface faulting is along existing fault traces that have had Holocene displacement. As previously discussed, the active Newport-Inglewood Fault is mapped through the Synergy Oil Field and City Property sites, as shown in Figure 3.5-2.
Seismic Groundshaking

As discussed above, it is estimated that a major earthquake has a 60 percent chance of affecting the Los Angeles Region in the next 30 years and would produce strong groundshaking throughout the region. Earthquakes on active or potentially active faults, depending on magnitude and distance from the project area, could produce a range of groundshaking intensities at the project area. Historically, earthquakes have caused strong groundshaking and damage in the Los Angeles Basin. For example, the Mw 6.4 Long Beach earthquake in March 1933 produced very damaging groundshaking from Long Beach to the industrial section south of Los Angeles (Hauksson and Gross 1991) and is believed to have occurred on the Newport-Inglewood Fault offshore from Huntington Beach (KCG 2016a); however, disregarding local variations in ground conditions, the intensity of shaking at different locations within the area can generally be expected to decrease with distance from an earthquake source.

The primary tool that seismologists use to describe groundshaking hazard is a probabilistic seismic hazard assessment (PSHA). The PSHA for the State of California takes into consideration the range of possible earthquake sources (including such worst-case scenarios as described above) and estimates their characteristic magnitudes to generate a probability map for groundshaking. The PSHA maps depict PGA values that have a 10 percent probability of being exceeded in 50 years (i.e., a 1 in 475 chance of occurring each year). Use of this probability level allows engineers to design structures to withstand ground motions that have a 90 percent chance of not occurring in the next 50-year interval, thus making buildings safer than if they were designed only for the ground motions that are expected within the next 50 years.

The geotechnical studies for the Synergy Oil Field, Pumpkin Patch, and LCWA sites provided the USGS estimates for the PGAs ranging from 0.603g to 0.604g (KCG 2016a, 2016b, 2016c). The PGA for the City Property site is expected to be in the same range. According to Table 3.5-1, this would correlate to a Modified Mercalli ground shaking intensity of level VIII, very strong shaking.

Liquefaction and Lateral Spreading

Liquefaction is the rapid loss of shear strength experienced in saturated, predominantly granular soils below the groundwater level during strong earthquake groundshaking and occurs due to an increase in pore water pressure. Liquefaction-induced lateral spreading is defined as the finite, lateral displacement of gently sloping ground as a result of pore-pressure buildup or liquefaction in a shallow underlying deposit during an earthquake (VT 2013). The occurrence of this phenomenon is dependent on many complex factors, including the intensity and duration of groundshaking, particle-size distribution, and density of the soil.

The potential damaging effects of liquefaction include differential settlement, loss of ground support for foundations, ground cracking, heaving and cracking of structure slabs due to sand boiling, and buckling of deep foundations due to ground settlement. Dynamic settlement (i.e., pronounced consolidation and settlement from seismic shaking) may also occur in loose, dry sands above the water table, resulting in settlement of and possible damage to overlying structures. In general, a relatively high potential for liquefaction exists in loose, sandy soils that are within 50 feet of the ground surface and are saturated (below the groundwater table). Lateral spreading can move blocks of soil, placing strain on buried pipelines that can lead to leaks or pipe failure.

Figure 3.5-5, Liquefaction Potential in Project Area, displays the relative liquefaction hazard potential in the vicinity of the proposed project; the entire area encompassing all four individual sites that comprise that proposed project is entirely within a liquefaction zone (CGS 1998). For the sites where buildings would be constructed,
during a 7.0-magnitude earthquake with a PGA of 0.601 g, an estimate of up to 1.3 to 2.7 inches of seismic settlement due to liquefaction and lateral spreading could occur at the Pumpkin Patch site (KCG 2016a) and up to 2.6 to 4.3 inches of seismic settlement at the LCWA site (KCG 2016b). This earthquake scenario represents the (worst-case) design-level earthquake and ground acceleration to be used for liquefaction analysis, as per ASCE/SEI 7-16, (see Section 3.5.3, Regulatory Framework, California Building Code). Although not specifically analyzed, the proposed location of the visitors center on the Synergy Oil Field site would be expected to experience less seismic settlement due to liquefaction because the proposed location in the southwest corner has not received multiple feet of uncompacted fill that the Pumpkin Patch and LCWA sites received.

Lateral spreading is characterized by horizontal displacement of surficial soil layers as a consequence of liquefaction of deeper granular soil layers. Lateral spreading usually occurs on sites with sloping ground surfaces located near bodies of water such as lakes, rivers and oceans.

Due to the gently sloping ground on the Pumpkin Patch site towards the nearby San Gabriel River and liquefaction potential, lateral spreading could occur at this site during the design maximum earthquake event (KCG 2016a). Due to the flatness of the LCWA site, the lack of slopes and distance to the nearest water body, lateral spreading is unlikely to occur during a design maximum earthquake event (KCG 2016b).

**Earthquake-Induced Settlement**

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid rearrangement, compaction, and settling of subsurface materials, particularly loose, uncompacted, and variable sandy sediments. Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or the waste material in the former landfill at the Synergy Oil Field, Pumpkin Patch, or LCWA sites (KCG 2016a).

**Landslides and Ground Cracking**

Earthquake motions can induce substantial stresses on slopes and can cause earthquake-induced landslides or ground cracking if the slope fails. Earthquake-induced landslides can occur in areas with steep slopes that are susceptible to strong ground motion during an earthquake. Landslides can also be non-seismically induced; non-seismically induced landslide can be caused by the force of gravity on steep unstable slopes, by construction activities that disturb soil conditions and create unstable slopes, and by water leaks or breaks in pipelines or pumps.

Based on a review of aerial photographs and available geotechnical reports and topographic conditions, no landslides are present at or at a location that could impact the Pumpkin Patch and LCWA sites (KCG 2016a, 2016b). Similarly, the Synergy Oil Field and City Property sites are relatively flat with no topography that could result in landslides. The City does not perceive slope instability as a major problem within the City, since its slopes are generally neither high nor steep (City of Long Beach 1975).

Landslides are ground failures that can occur in areas with steep slopes. The failures can occur quickly as mass failures or as slower incremental creep or flow failures. The geotechnical surveys for the Synergy Oil Field and City Property sites did not evaluate the potential for landslides; however, given the relatively flat nature of these two sites, the potential for landslides would be considered low.
Figure 3.5-5
Liquefaction Potential in Project Area

SOURCE: ESRI; City of Long Beach 2015; CGS 1999

Project Site
City Property Site Boundary
LCWA Site Boundary
Pumpkin Patch Site Boundary
Synergy Oil Field Site Boundary
Liquefaction Areas

Long Beach Cerritos Wetland. 150712
Path: U:\GIS\GIS\Projects\15xxxx\D150712_Long_Beach_Cerritos_Wetland\Liquefaction.mxd, janderson 7/12/2017
3.5.3 Regulatory Framework

The project shall be required to comply with the following laws, statutes, regulations, codes, and policies, which are defined as standard conditions for the project.

3.5.3.1 Federal

Earthquake Hazards Reduction Act

Established by the U.S. Congress when it passed the Earthquake Hazards Reduction Act of 1977, the purpose of the National Earthquake Hazards Reduction Program (NEHRP) is to “reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program.” The principle behind NEHRP is that earthquake-related losses can be reduced through improved design and construction methods and practices, land use controls and redevelopment, prediction techniques and early-warning systems, coordinated emergency preparedness plans, and public education and involvement programs. There are four federal agencies that can contribute to earthquake mitigation efforts; they have been designated as NEHRP agencies and are as follows: the Federal Emergency Management Agency (FEMA), the National Institute of Standards and Technology (NIST), the National Science Foundation (NSF), and the USGS.

Hazardous Liquid Pipeline Safety Act

The Hazardous Liquid Pipeline Safety Act of 1979 authorized the U.S. Department of Transportation (USDOT) to regulate pipeline transportation of hazardous liquids, including crude oil, petroleum products, anhydrous ammonia and carbon dioxide. The Pipeline and Hazardous Materials Safety Administration (PHMSA), created in 2004 by USDOT, has the following responsibilities:

- Analyze pipeline safety and accident data;
- Evaluate which safety standards need improvement and where new rulemakings are needed;
- Set and enforce regulations and standards for the design, construction, operation, maintenance, or abandonment of pipelines by pipeline companies;
- Educate operators, states, and communities on how to keep pipelines safe;
- Facilitate research and development into better pipeline technologies;
- Train state and federal pipeline inspectors; and
- Administer grants to states and localities for pipeline inspections, damage prevention, and emergency response.

The requirements of the Hazardous Liquid Pipeline Safety Act are implemented by DOGGR, as discussed further below. The federal- and State-level regulations cover route selection, regulatory processes, design, site preparation, pipe stringing, trenching, bending, welding, coating, lowering and backfilling, testing, and site restoration.
3.5.3.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to protect structures for human occupancy from the hazard of surface faulting. In accordance with the act, the State Geologist has established regulatory zones—called earthquake fault zones—around the surface traces of active faults, and has published maps showing these zones. Buildings for human occupancy cannot be constructed across surface traces of faults that are determined to be active. Because many active faults are complex and consist of more than one branch that may experience ground surface rupture, earthquake fault zones extend approximately 200 to 500 feet on either side of the mapped fault trace. This act applies to this project because the active Newport-Inglewood Fault passes through two of the individual sites that compose the project site.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was passed in 1990 following the Loma Prieta earthquake to reduce threats to public health and safety and to minimize property damage caused by earthquakes. This act requires the State Geologist to delineate various seismic hazard zones, and cities, counties, and other local permitting agencies to regulate certain development projects within these zones. For projects that would locate structures for human occupancy within designated Zones of Required Investigation, the Seismic Hazards Mapping Act requires project applicants to perform a site-specific geotechnical investigation to identify the potential site-specific seismic hazards and corrective measures, as appropriate, prior to receiving building permits. The CGS Guidelines for Evaluating and Mitigating Seismic Hazards (Special Publication 117A) provides guidance for evaluating and mitigating seismic hazards (CGS 2008). The CGS is in the process of producing official maps based on USGS topographic quadrangles. To date, the CGS has completed delineations for the USGS quadrangles in which project components are proposed and the Synergy Oil Field and City Property sites are within a seismic hazard zone. Therefore, the proposed project is subject to the act.

California Building Code

The California Building Code (CBC), which is codified in Title 24 of the California Code of Regulations, Part 2, was promulgated to safeguard the public health, safety, and general welfare by establishing minimum standards related to structural strength, means of egress to facilities (entering and exiting), and general stability of buildings. The purpose of the CBC is to regulate and control the design, construction, quality of materials, use/occupancy, location, and maintenance of all buildings and structures within its jurisdiction. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under State law, all building standards must be centralized in Title 24 or they are not enforceable. The provisions of the CBC apply to the construction, alteration, movement, replacement, location, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

design and includes means for determining earthquake loads as well as other loads (such as wind loads) for inclusion into building codes. Seismic design provisions of the building code generally prescribe minimum lateral forces applied statically to the structure, combined with the gravity forces of the dead and live loads of the structure, which the structure then must be designed to withstand. The prescribed lateral forces are generally smaller than the actual peak forces that would be associated with a major earthquake. Consequently, structures should be able to (1) resist minor earthquakes without damage; (2) resist moderate earthquakes without structural damage but with some nonstructural damage; and (3) resist major earthquakes without collapse, but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a structure designed in accordance with the seismic requirements of the CBC should not collapse in a major earthquake.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, all of which are used to determine a seismic design category (SDC) for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site; SDC ranges from A (very small seismic vulnerability) to E/F (very high seismic vulnerability and near a major fault). Seismic design specifications are determined according to the SDC in accordance with CBC Chapter 16. CBC Chapter 18 covers the requirements of geotechnical investigations (Section 1803), excavation, grading, and fills (Section 1804), load-bearing of soils (Section 1806), as well as foundations (Section 1808), shallow foundations (Section 1809), and deep foundations (Section 1810). For Seismic Design Categories D, E, and F, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses measures to be considered in structural design, which may include ground stabilization, selecting appropriate foundation type and depths, selecting appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions.

Requirements for geotechnical investigations are included in Appendix J, CBC Section J104, Engineered Grading Requirements. As outlined in Section J104, applications for a grading permit are required to be accompanied by plans, specifications, and supporting data consisting of a soils engineering report and engineering geology report. Additional requirements for subdivisions requiring tentative and final maps and for other specified types of structures are in California Health and Safety Code Sections 17953 to 17955 and in 2013 CBC Section 1802. Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be done as needed to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on load-bearing capacity, compressibility, liquefaction, differential settlement, and expansiveness.

The design of the proposed action is required to comply with CBC requirements, which would make the proposed action consistent with the CBC.

42 A load is the overall force to which a structure is subjected in supporting a weight or mass, or in resisting externally applied forces. Excess load or overloading may cause structural failure.
NPDES Construction General Permit

Construction associated with the proposed project would disturb more than 1 acre of land surface affecting the quality of stormwater discharges into waters of the U.S. The proposed project would, therefore, be subject to the NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ). The Construction General Permit regulates discharges of pollutants in stormwater associated with construction activity to waters of the U.S. from construction sites that disturb 1 acre or more of land surface, or that are part of a common plan of development or sale that disturbs more than 1 acre of land surface. The permit regulates stormwater discharges associated with construction or demolition activities, such as clearing and excavation; construction of buildings; and linear underground projects, including installation of water pipelines and other utility lines.

The Construction General Permit requires that construction sites be assigned a Risk Level of 1 (low), 2 (medium), or 3 (high), based both on the sediment transport risk at the site and the receiving waters risk during periods of soil exposure (e.g., grading and site stabilization). The sediment risk level reflects the relative amount of sediment that could potentially be discharged to receiving water bodies and is based on the nature of the construction activities and the location of the site relative to receiving water bodies. The receiving waters risk level reflects the risk to the receiving waters from the sediment discharge. Depending on the risk level, the construction projects could be subject to the following requirements:

- Effluent standards;
- Good site management “housekeeping;”
- Non-stormwater management;
- Erosion and sediment controls;
- Run-on and runoff controls;
- Inspection, maintenance, and repair; or
- Monitoring and reporting requirements.

The Construction General Permit requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) that includes specific best management practices (BMPs) designed to prevent sediment and pollutants from contacting stormwater from moving off site into receiving waters. The BMPs fall into several categories, including erosion control, sediment control, waste management and good housekeeping, and are intended to protect surface water quality by preventing the off-site migration of eroded soil and construction-related pollutants from the construction area. Routine inspection of all BMPs is required under the provisions of the Construction General Permit. In addition, the SWPPP is required to contain a visual monitoring program, a chemical monitoring program for non-visible pollutants, and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment.

The SWPPP must be prepared before the construction begins. The SWPPP must contain a site map(s) that delineates the construction work area, existing and proposed buildings, parcel boundaries, roadways, stormwater collection and discharge points, general topography both before and after construction, and drainage patterns across the project area. The SWPPP must list BMPs and the placement of those BMPs that the applicant would use to protect stormwater runoff. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for “non-visible” pollutants to be implemented if there is
a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment. Examples of typical construction BMPs include scheduling or limiting certain activities to dry periods, installing sediment barriers such as silt fence and fiber rolls, and maintaining equipment and vehicles used for construction. Non-stormwater management measures include installing specific discharge controls during certain activities, such as paving operations, vehicle and equipment washing and fueling. The Construction General Permit also sets post-construction standards (i.e., implementation of BMPs to reduce pollutants in stormwater discharges from the site following construction).

In the project area, the Construction General Permit is implemented and enforced by the Los Angeles Regional Water Quality Control Board (LARWQCB), which administers the stormwater permitting program. Dischargers are required to electronically submit a notice of intent (NOI) and permit registration documents (PRDs) in order to obtain coverage under this Construction General Permit. Dischargers are responsible for notifying the LARWQCB of violations or incidents of non-compliance, as well as for submitting annual reports identifying deficiencies of the BMPs and how the deficiencies were corrected. The risk assessment and SWPPP must be prepared by a State Qualified SWPPP Developer and implementation of the SWPPP must be overseen by a State Qualified SWPPP Practitioner. A Legally Responsible Person, who is legally authorized to sign and certify PRDs, is responsible for obtaining coverage under the permit.

**Division of Oil, Gas, and Geothermal Resources**

All California oil and gas wells (development and prospect wells), enhanced-recovery wells, water-disposal wells, service wells (i.e., structure, observation, temperature observation wells), core-holes, and gas-storage wells, onshore and offshore (within 3 nautical miles of the coastline), located on state and private lands, are permitted, drilled, operated, maintained, plugged, and abandoned under requirements and procedures administered by the Department of Conservation’s Division of Oil, Gas, and Geothermal Resources (DOGGR).

Regulations pertaining to oil and natural gas production are summarized in the DOGGR Publication No. PRC10, California Statutes and Regulations for Conservation of Oil, Gas, & Geothermal Resources, dated January 2017. Regulations for the installation and abandonment of oil and natural gas wells are in 14 CCR 1712 through 1724.10. Environmental protection regulations for oil and natural gas well installations, operations, and abandonments are in 14 CCR 1750 through 1789.

**California Pipeline Safety Act of 1981**

The California Pipeline Safety Act of 1981, codified in California Government Code Sections 50001–51298.5, applies to pipelines that carry hazardous liquids (e.g., crude oil) and authorizes the State Fire Marshal to implement the federal Hazardous Liquid Pipeline Safety Act, as summarized above. This Act imposes additional specific safety requirements on intrastate pipelines carrying hazardous liquids, including a time schedule for conformance to federal regulations, hydrostatic testing requirements, pipeline maps, contingency plans, and pipeline incident reporting.

**3.5.3.3 Local**

**Long Beach MS4 Permit**

The City is covered under the Long Beach MS4 Permit: Waste Discharge Requirements for Municipal Separate Storm Sewer System Discharges from the City; Order No. R4-2014-0024 (LARWQCB 2014).
According to the MS4 Permit, new development projects are as follows:

- Industrial parks
- Parking lots 5,000 square feet (sf) or more of impervious surface area or with 25 or more parking spaces;
- All development projects equal to 1 acre or greater of disturbed area and adding more than 10,000 sf of impervious surface area;

According to the MS4 Permit, redevelopment projects are as follows:

- Land-disturbing activity that results in the creation or addition or replacement of 5,000 sf or more of impervious surface area on an already developed site for development categories/project thresholds.
- Where redevelopment results in an alteration to more than 50 percent of impervious surfaces of a previously existing development, and the existing development was not subject to post-construction stormwater quality control requirements, the entire project must be mitigated.
- Where redevelopment results in an alteration of less than 50 percent of impervious surfaces of a previously existing development, and the existing development was not subject to post-construction stormwater quality control requirements, only the alteration must be mitigated, and not the entire development.

The MS4 Permit lists conditions for various specific discharge categories, including landscape irrigation using potable water, landscape using reclaimed or recycled water, and street/sidewalk wash water. Conditions are also required for exempt MS4 discharges. Table 9 of the MS4 Permit lists source control BMPs pertaining to pollutant-generating activities to be implemented at commercial and industrial facilities.

The MS4 permit requires the City to develop and implement the Long Beach Storm Water Management Program and the Long Beach Low Impact Development (LID) Manual described below.

**Long Beach Storm Water Management Program**

The LARWQCB issued the City its own NPDES permit (NPDES Permit No. 99-060; CAS004003/CI 8052). As part of its Report of Waste Discharge submitted for its NPDES permit, the City included among other programs, a stormwater management program. In accordance with the objectives of the federal Clean Water Act and the State Porter-Cologne Water Quality Control Act, the Long Beach Storm Water Management Program contains elements, practices, and activities to reduce or eliminate pollutants in stormwater to the maximum extent practicable (City of Long Beach 2001). In accordance with this program, Long Beach Municipal Code (LBMC) Chapter 18.95 includes requirements relating to development planning and construction, including source control BMPs. Additional requirements include treatment control BMPs and requirements regarding erosion control, peak runoff, and BMP maintenance for projects located adjacent to or directly discharging to environmentally sensitive areas. Post-construction structural or treatment control BMPs designed to mitigate (infiltrate or treat) the volume of runoff produced from a 0.75-inch storm event prior to its discharge to a stormwater conveyance system are also required for these specific projects. In addition, in accordance LBMC Chapter 8.96, construction projects are required to prepare a SWPPP that will incorporate construction site BMPs.

Given the potential for the proposed project to contribute pollutant loads to stormwater flows during construction and operation of proposed uses, the project is subject to the requirements of the NPDES permits and municipal code requirements.
The City adopted LID regulations for the purpose of:

- Encouraging the beneficial use of rainwater and urban runoff;
- Reducing stormwater/urban runoff while improving water quality;
- Reducing off-site runoff and providing increased groundwater recharge;
- Reducing erosion and hydrologic impacts downstream; and
- Enhancing the recreational and aesthetic values in our communities.

This LID objective of controlling and maintaining flow rate is addressed through land development and stormwater management techniques that imitate the natural hydrology (or movement of water) found on the site. Using site design and BMPs that allow for storage and retention, infiltration, filtering and flowrate adjustments achieve this objective.

These regulations apply to all development and redevelopment in the City, with some exceptions. The following LID regulations specifically apply to slopes and channels to prevent erosion:

1. Slopes must be protected from erosion by safely conveying runoff from the tops of slopes.
2. Slopes must be vegetated with first consideration given to native or drought-tolerant species.
3. Utilize natural drainage systems to the maximum extent practicable, but minimize runoff discharge to the maximum extent practicable.
4. Stabilize permanent channel crossings.
5. Install energy dissipaters, such as rock riprap, at the outlets of storm drains, culverts, conduits, or channels that discharge into unlined channels.

By identifying the locations and sources of off-site drainage, the volume of water running onto the site may be estimated and factored into the siting and sizing of on-site BMPs. Vegetated swales or storm drains may be used to intercept, divert, and convey off-site drainage through or around a site to prevent flooding or erosion that might otherwise occur (City of Long Beach 2013). The above-described Long Beach Storm Water Management Program requires that each project prepare and implement a project-specific LID Plan. The proposed project has prepared project-specific LID Plan (Wilson Mikami 2017).

**Long Beach Municipal Code**

**Chapter 8.96. Stormwater and Runoff Pollution Control.** This chapter reinforces the requirements of the Federal Clean Water Act and the State Porter Cologne Act (including Construction General Permit requirements) within the City.

**Chapter 18.04: Permits.** This chapter describes various permit requirements within the City.

**Section 18.04.010.** Building permits are required for any attempt to erect, construct, enlarge, alter, repair, remodel, move, remove, improve, convert or demolish any building or part of a building or structure, or change the character or occupancy or use of any building or structure, or part of a building or structure. Building permits must be obtained from the City Building Official.

Grading permits are required for grading and import or export any earth materials to or from any grading site. Grading permits must be obtained from the City Building Official. Any grading project involving more than 100 cubic yards of excavation and involving an excavation in excess of five feet
in vertical depth at its deepest point measured from the original ground surface shall be done by a State of California licensed contractor who is licensed to perform the work described herein. A separate permit shall be required for each grading site. One permit may include the entire grading operation at that site, however.

No permit shall be issued for projects located within a special (fault) studies zone established under Chapter 7.5, Division 2, of the California Public Resources Code unless it can be demonstrated through accepted geologic seismic studies that the proposed structure will be located in a safe manner and not over or astraddle the trace of an active fault. Acceptable geologic seismic studies shall meet the criteria as set forth in rules and regulations established by the Building Official to ensure that such studies are based on sufficient geologic data to determine the location or nonexistence of the active fault trace on a site. Prior to approval of a project, a geologic report defining and delineating any hazard of surface fault rupture shall be required. If the City finds that no undue hazard of this kind exists, the geologic report on such hazard may be waived, with approval of the State Geologist.

Chapter 18.40: Building Code. This chapter describes the reinforcement of the CBC within the City with the exception of some sections of the Code.

Chapter 18.68: Earthquake Hazard Regulations. This chapter defines a systematic procedure for identifying and assessing earthquake generated hazards associated with certain existing structures within the City and to develop a flexible, yet uniform and practical procedure for correcting or reducing those hazards to tolerable hazard levels. This chapter includes minimum standards for structural seismic resistance established to reduce the risk of life loss or injury.

City of Long Beach General Plan

Seismic Safety Element—1988

Advance Planning Recommendations—Land Use

- Priority should be given to low risk type projects such as low rise buildings and open space in areas of known seismic hazards.
- Density is a seismic safety consideration in that higher occupancy results in greater risk exposure to more people should an earthquake occur. Therefore, from a seismic safety perspective, lower densities are often preferred.
- Hazardous activities, such as petroleum operations, should be buffered to the extent possible from other types of land uses. The isolation of activities would serve to lessen exposure of such operations to the general public.

Immediate Action Recommendations—Structure and Design

- The siting and design recommendations, as specified in Table 6 of the General Plan, should be seriously considered for implementation. Special siting and design studies must be completed for specified structural types in specified Seismic Response Zones.
- No structures for human occupancy defined as “project” within the Alquist-Priolo Special Studies Zones Act and essential facilities and hazardous facilities involving sufficient quantities of toxic or explosive materials presenting a danger to the public safety if released and located with the delineated Caution Zones shall be approved without geologic and earthquake hazard reports. These reports should be completed in accordance with the “guidelines to Geologic/Seismic Reports,” as provided by the State Division of Mines and Geology, and/or in accordance with the policies and criteria of the State Mining and Geology Board with reference to the Alquist-Priolo Geologic Hazards Zones Act.
- No structure for human occupancy shall be permitted to be placed across the trace of an active fault, i.e., the Newport-Inglewood Fault.
Public Safety Element

Advance Planning Recommendations

- New development should be responsive to seismic considerations (see Seismic Safety Element).

Conservation Element

Soil Management Goals

- To minimize those activities which will have a critical or detrimental effect on geologically unstable areas and soils subject to erosion.
- To continue to monitor areas subject to siltation and deposition of soils which could have a detrimental effect upon water quality and the marine biosphere.

Southeast Area Development and Improvement Plan and Draft Southeast Area Specific Plan

Approved in 1977, the Southeast Area Development and Improvement Plan (SEADIP) was the first planned development district in the City. The SEADIP document was intended to guide land use and development in an area that was experiencing a period of rapid growth. The 1977 SEADIP included the following planning goals and objectives relevant to geology, seismicity, and soils:

Environmental Consideration, page 15: Seismic safety will be ensured by meeting the requirements of the Seismic Safety Element and the Alquist-Priolo Act, which will ultimately govern the actual development capability of the affected lands.

The SEADIP includes updates, revisions, and additions of the ordinance history through 2006. The additions through 2006 include narrative discussion of “The Wetlands” and “The Buffers,” which would include the restoration area. Relative to geology, seismicity, and soil, the narrative is largely permit, process, phasing, and financially oriented.

In July 2016, the City circulated a draft of the Southeast Area Specific Plan (SEASP), which is a planning document for the project area, including re-designating land uses for the project site (City of Long Beach 2016). It is anticipated that the SEASP will be completed and issued as in its final form within the lifetime of the proposed project are provided here for informational purposes. The portions relevant to geology, seismicity, and soils are provided below.

Chapter 5, Development Standards, Section 5.10, Wetland Buffers

Be designed, where necessary, to help minimize the effects of erosion, sedimentation, and pollution arising from urban, industrial and agricultural activities; however, to the extent possible, erosion, sedimentation, and pollution control problems should be dealt with at the source, not in the wetland or buffer area.

Chapter 8, Infrastructure, Section 8.1.2, Storm Drains

Any new projects in the SEASP area will have to comply with the MS4 Permit for the City and include stormwater LID BMPs. Such features will ensure any increases in runoff from proposed land use changes will be sustainably managed and that the 85th percentile, 24-hour storm event will be treated through a variety of LID features. The 85th percentile storm event is measured by rainfall depth; for example, if the 85th percentile storm event equals 0.5 inch, then 85 percent of all rainfall events will be equal to 0.5 inch or less of precipitation.
The use of LID features will be consistent with the prescribed hierarchy of treatment provided in the permit: infiltration, evapotranspiration, harvest/reuse, and biotreatment. For areas of the site where LID features are not feasible or that do not meet the feasibility criteria, treatment control BMPs with biotreatment enhancement design features must be used.

Typical water quality BMPs for new development in mixed-use areas include stormwater planters (raised or at grade), cisterns and reuse distribution systems (primarily for landscaping), proprietary detention/biotreatment flow-through systems, and subterranean infiltration systems. Since increased density is anticipated in mixed-use areas, the majority of the proposed features should be located within the landscaping along the perimeter of the project, adjacent to the buildings, or in some cases, within the buildings themselves.

3.5.4 Analysis of Impacts

This section describes the impact analysis relating to geology and soils for the proposed project. It describes the methods and applicable thresholds used to determine the impacts of the proposed project.

3.5.4.1 Significance Criteria

CEQA Guidelines Appendix G provides that a project would have a significant geology and soils impact if it would:

- 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. (Refer to Division of Mines and Geology Special Publication 42);
  - Strong seismic ground shaking;
  - Seismic-related ground failure, including liquefaction;
  - Landslides;
- Result in substantial soil erosion or the loss of topsoil;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- Be located on expansive soil, as defined in Table 18-1-B of the UBC, creating substantial risks to life or property; or
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

It was determined in the NOP/IS (see Appendix A) that implementation of the proposed project would have no impact with regard to the use of septic tanks or alternative water disposal systems. Development of the project would be anticipated to connect to the City’s existing sewer lines and wastewater disposal systems. Therefore, this topic will not be discussed in the EIR.

---

43 The CBC, based on the IBC and the now-defunct UBC, no longer includes a Table 18-1-B. Instead, CBC Section 1803.5.3 describes the criteria for analyzing expansive soils.
3.5.4.2 Methodology

General

This impact section assesses potential impacts related to geology, seismicity, and soils based on the potential for the project to change geologic and soil conditions or expose facilities or people to unstable geologic conditions during project activities, using existing site conditions as a baseline for comparison. The potential for damage to proposed facilities or increased risk of injury due to geologic hazards is analyzed using available data from site-specific investigations including the geotechnical reports prepared for the project site (KCG 2016a, 2016b), Phase I environmental site assessments (AEC 2016a, 2016b; Rincon 2015), white papers describing the operation of the project (BOMP 2017a, 2017b, 2017c), and existing publications and maps completed by federal, state local and agencies, such as the NRCS and the City. In addition, the severity and significance of geology and soils impacts are analyzed in the context of existing geologic and seismic hazard regulations and policies. A project is required to comply with all applicable regulations as a requirement for to obtain building and occupancy permits.

For purposes of this analysis, construction activities would include the excavation of soils and previously landfilled materials; removal of some existing oil production facilities (wells, piping, and associated infrastructure); construction of aboveground structures including the office building, oil production facilities, trail, parking lot, driveway improvements, and restored habitat; and the relocation of the Synergy office and placement on a new foundation. These construction activities would occur at various times spread out over time across the entire project site. Operations activities would include the operational phases of the office buildings, oil production facilities, trail, visitors center, parking lot, driveway and restored habitat, but do not include soil excavation. In addition, the operations activities include the post-treatment monitoring activities conducted to verify that remedial objectives have been achieved.

As stated in Chapter 1, Introduction, on April 28, 2016, the City sent an NOP to responsible, trustee, and federal agencies, as well as to organizations, and individuals potentially interested in the project to identify the relevant environmental issues that should be addressed in the EIR. Comments were received about the use of fracking to install oil production wells; however, fracking is not proposed for use and the topic of fracking is not considered further (BOMP 2017a, 2017b). No other issues related to geology, seismicity, or soils were identified in the received comments.

Hydraulic Modeling

Hydraulic modeling was a primary analytical tool used to evaluate proposed project impacts on flooding and erosion. This section describes the hydraulic model and how it was used to simulate the surface water response to the proposed project during typical tides and storm events. The results of the hydraulic modeling are presented in Appendix G3, the Updated Sea Level Rise Impact Analyses (M&N 2017).

Hydraulic Model Definition

Hydraulic models are computer simulations that represent water flow in the environment using mathematical equations. By mathematically representing a simplified version of a surface water system, reasonable scenarios can be predicted, tested, and compared. The applicability or usefulness of a model depends on how closely the mathematical equations approximate the physical system being modeled.
After a model has been set up for existing conditions, it then is verified against known information. Simulations are run for measured flow rates, and model results are compared to observed/measured water elevations or velocities. The various input parameters then are adjusted to better simulate observed conditions. When measured flow data are not available, model parameters are selected based on available information and professional judgment.

Model results for existing conditions then are used as a baseline for evaluating the potential hydraulic impacts of proposed changes, such as expansion of a floodplain, construction of a bridge, or enlargement of culverts. For this analysis, the proposed project was modeled and the results were compared to the existing conditions model results to identify potential impacts.

**Hydraulic Model Terminology**

Certain terminology is used in hydraulic modeling to describe and illustrate the nature, extent, and movement of surface water and the responses to changes. Key terms are presented below.

- **100-year Flow/Flood/Storm/Event**—A storm/flood/event expected to occur once every 100 years or with an annual probability of occurring of 1 percent. Any X-year event is expected to occur once every X years or with a 100/X percent chance of annual occurrence.
- **Freeboard**—The distance between the water surface and the lowest possible entry point along a levee or berm during flooding or large waves.
- **MLLW**—Mean lower low water, average height of the lowest tide each day.
- **MHHW**—Mean higher high water, average height of the highest tide each day.
- **Tidal Prism**—The volume of water that is exchanged in a given tidal area between MLLW and MHHW.

**Limitations of Hydraulic Models**

Hydraulic models use simplified mathematical equations to represent extremely complex natural systems. Therefore, significant uncertainty is inherent in model results, even when parameters have been calibrated to measured data. Nonetheless, hydraulic modeling is a standard tool for project planning, design and impact analysis, and the results provide a basis for comparing the hydraulic performance of different scenarios relative to a baseline.

**Adaptive Hydraulics Model**

Adaptive hydraulics (AdH) two-dimensional numerical models were created to simulate hydraulic conditions under the existing and proposed project conditions. The models were run for the following three sea level rise and storm flow conditions to assess potential impacts of the proposed project:

- The lower bound of sea level rise projections of 0.5 foot in year 2060;
- The upper bound of sea level rise projections of 2.6 feet in year 2060; and
- The upper bound of sea level rise projections of 2.6 feet in year 2060 together with a 50-year fluvial storm.

The models were also run for average tidal conditions to assess scour potential in Steamshovel Slough and the proposed project area.
3.5.4.3 Impact Evaluation

Impact GEO-1: The project would not expose people or structures to potential substantial adverse effects as a result of rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map. (Less than Significant)

The Newport-Inglewood Fault Zone is designated by the State as an Alquist-Priolo Earthquake Fault Zone (i.e., on a state-recognized active fault trace) that crosses the Synergy Oil Field and City Property sites, as shown in Figure 3.5-2. In the event of an earthquake along the Newport-Inglewood Fault Zone, fault rupture could occur on these two sites. The Newport-Inglewood Fault Zone passes near but not through the Pumpkin Patch and LCWA sites.

Construction

Proposed Synergy Oil Field site construction activities within the fault zone include the relocation of the existing building (to be repurposed as a visitors center) to the southwest corner of the Synergy Oil Field site outside of the fault zone, as shown in Figure 2-22, Pumpkin Patch Site Habitat Buffer Area. This relocation would reduce the risk of fault rupture damaging the building or injuring people by relocating the structure outside of the fault zone by approximately 1,000 feet to the southwest. As described in Chapter 2, 95 percent of aboveground pipelines and all storage tanks, would be removed from the Synergy Oil Field site during the first phase of the project, with the remaining infrastructure removed later as wells are removed. Oil wells and associated infrastructure would be removed if the oil production in each well decreases to less than one full barrel of oil per day for a period of 18 consecutive months or within 40 years from the New Occupancy Date (described in Chapter 2, Project Description, as completion and occupancy of the oil production facilities on the Pumpkin Patch and LCWA sites, and the office facility on the Pumpkin Patch site). The habitat restoration construction activities would include soil excavation, berm and trail construction, and ecosystem restoration. These construction activities would not alter the seismic environment or increase the risk of fault rupture. The removal and relocation of various structures would reduce the risk of exposure to fault rupture. Therefore, impacts related to fault rupture on the Synergy Oil Field site would be less than significant.

Similar to the Synergy Oil Field Site, the proposed construction activities on the City Property site would involve the removal of existing oil production wells and associated infrastructure if the oil production in each well decreases to less than one full barrel of oil per day for a period of 18 consecutive months or within 40 years from the New Occupancy Date. Two to three of the wells on the City Property site are located within the Alquist-Priolo fault zone (Newport-Inglewood Fault) and would be plugged and abandoned at some time in the future, which would reduce the risk of damage to an operating oil well. As described in Chapter 2, Project Description, an oil pipeline system and utility corridor would be constructed to transport oil from the Pumpkin Patch site, through the City Property site, to the LCWA site, as shown in Figure 2-10, Pumpkin Patch Site, and Figure 2-11, Los Cerritos Wetlands Authority (LCWA) Site. The likelihood of a fault rupture occurring during construction would be relatively low with minimal risk of injury or property damage because the pipeline would be constructed over a relatively short period of time and does not include habitable structures (workers would not be on site for extended time periods and within or near tall structures that could collapse or shed debris during a seismic event). The risk to the pipelines and utilities would occur during the operations phase when the pipelines are carrying oil and utilities are operational, as discussed below. Impacts related to fault rupture on the City Property site during construction would be less than significant.
The Pumpkin Patch and LCWA sites are not located within the Newport-Inglewood Fault Zone. Therefore, although fault rupture is possible along new or unknown fault traces, the likelihood of a fault rupture occurring during construction would be relatively low with minimal risk of injury or property damage because construction would occur over a relatively short period of time and the buildings would not be occupied until after construction is complete. The more likely potential risk to buildings, wells, well cellars, and associated infrastructure would occur during the operations phase after construction and more in response to seismic shaking and seismic-related ground failures, as discussed further below. Impacts related to fault rupture on the Pumpkin Patch and LCWA sites during construction would be less than significant.

**Operation**

**Induced Fault Rupture, Seismic Event, and/or Seismic-Related Ground Failure**

As discussed in Chapter 2, *Project Description*, the older wells on the Synergy Oil Field, City Property, and Pumpkin Patch sites would be replaced with newer wells installed on the Pumpkin Patch and LCWA sites over time. The newer wells would be installed using directional drilling techniques that would target oil production zones. Some of the zones could be close to or bordered by the Newport-Inglewood Fault Zone. The removal of oil and produced water from the subsurface would reduce the volume of fluids in the production zone and, if not replaced, could result in a vacancy or voids that could cause subsidence that in turn could trigger a fault rupture, seismic event, and/or seismic-related ground failure. Discussions of researched cases where subsidence and seismic activity has been attributed to oil production are discussed in the white papers on Induced Seismicity (BOMP 2017b) and Water Injection (BOMP 2017c).

To prevent this, the oil industry has long used the practice of injecting the produced water that has been separated from the oil back into the production zone in order to avoid potential subsidence that could result if the vacancy or voids created by extraction of oil and water from the oil production zone is not refilled. The injection of water back into the production zone would prevent subsidence and reduce the potential to trigger fault rupture, seismic events, and seismic-related ground failure. If additional water is needed, water source wells would be used to extract groundwater from zones not susceptible to subsidence to augment the water that is pumped back into the oil production zones. Consistent with DOGGR regulations (see Section 3.5.3, DOGGR regulations), all injection wells would be equipped with an accurate, operating pressure gauge or pressure recording device and underground reservoir pressures would be closely monitored. As discussed in the above-reference white papers, the injection would be specifically and only back into the same oil production zone and not into underlying units; some induced seismic activity has been attributed to this practice. With the refilling of the oil production zone vacancies, the potential to induce seismic activity would be reduced to a less-than-significant level.

**Impacts Related to the Future Restoration Area on Synergy Oil Field**

For the Synergy Oil Field site, portions of the proposed trail and restored ecosystem area would be located within the Newport-Inglewood Fault Zone and could be exposed to fault rupture; however, these project components do not include aboveground structures that could be damaged by fault rupture during operation. Further, restored areas would not contain large amounts of people during operation. Restoration monitors would inspect the site on a routine but occasional basis. The trail would only be open to the public for specific daytime hours, thereby limiting the use and presence of persons on site. Therefore, based on the proposed uses, limited hours of use and anticipated number of people visiting the site, exposure of people to fault rupture impacts on the Synergy Oil Field site during project operation would be unlikely, and impacts would be less than significant.
Impacts Related to the Future Pipeline and Utilities across City Property Site

As discussed above, a pipeline system and utility corridor would be constructed to transport oil, water, natural gas, electricity and communication lines from the Pumpkin Patch site through the City Property site to the LCWA site, as shown in Figure 2-10 and Figure 2-11. The proposed pipelines, electrical lines, and control cables were evaluated for potential displacement or damage in the event of a seismic event (Honegger 2016). The study identified seismic design elements to accommodate the anticipated maximum amount of displacement and minimize the damage risk from rupture. The study considered inelastic pipeline behavior, the nonlinear behavior of the surrounding soil mass, and large displacement effects, and analyzed both aboveground and below ground pipeline configurations. The study concluded that maximizing an aboveground pipeline configuration would enable the pipeline to accommodate a larger amount of fault offset and still operate safely. The aboveground fault crossing design would allow relative lateral displacement to be accommodated by sliding on the aboveground supports and accommodate relative axial displacement through flexure of bends in the pipeline. In addition, the pipeline would have stress loops, pressure gauges, automatic shutoff devices, alarms, and valves at specific distances, as required by DOGGR and summarized in their Publication No. PRC 10, noted in Section 3.5.3, which would shut the pipeline system down in the event that a seismic event compromised the system. Implementation of the geotechnical recommendations for pipeline safety is a standard condition (required by law) required by DOGGR, which would reduce the potential impact to a less-than-significant level.

Impacts Related to the Future Structures on Pumpkin Patch and LCWA sites

As previously discussed, the Pumpkin Patch and LCWA sites are not located within the Newport-Inglewood Fault Zone. Therefore, although fault rupture is possible along new or unknown fault traces, the likelihood of a fault rupture occurring during operations would be relatively low. The larger potential risk to buildings, wells, well cellars, and associated infrastructure would occur more in response seismic shaking and seismic-related ground failures, as discussed further below. Impacts related to fault rupture during operations for the Pumpkin Patch and LCWA sites would be less than significant.

Mitigation Measures: None required.

Significance Determination: Less than Significant.

Impact GEO-2: The project would not expose people or structures to potential substantial adverse effects as a result of strong seismic ground shaking. (Less than Significant with Mitigation)

In addition to the Newport-Inglewood Fault Zone that crosses the Synergy Oil Field and City Property sites as shown in Figure 3.5-2, there are numerous other active faults in the region, as shown in Figure 3.5-1. As discussed above in Section 3.5.2.3, Seismicity and Faults, the region will likely experience a large regional earthquake within the operational life of the project. There is a potential for high-intensity groundshaking at the project site that would be associated with such an earthquake. The intensity of such an event would depend on the causative fault and the distance to the epicenter, the Mw, the duration of shaking, and the nature of the geologic materials on which the project components would be constructed. Intense groundshaking and high ground accelerations would affect the entire area around the proposed facilities, wells, and associated infrastructure. The primary and secondary effects of groundshaking could damage structural foundations, distort or break wells or pipelines, and place people at risk of injury or death. The impact from induced seismic activity caused by oil production was analyzed above in Impact GEO-1.
Construction

As described in Section 3.5.2, Environmental Setting, the project site is located within a seismically active region and is anticipated to be subjected to seismic shaking during the life of the project due to the multiple faults within the region. Therefore, in the event of an earthquake along the Newport-Inglewood Fault Zone or any other active regional fault, partially constructed or removed aboveground structures and construction workers could be exposed to ground shaking on all four individual sites that comprise the project site; however, the construction period is short term, with most construction workers located outside of any structures.

More importantly, the structural elements of the proposed project (i.e., the structures on the Pumpkin Patch and LCWA sites, and the oil pipeline and utilities from the LCWA site through the City Property site to the Pumpkin Patch site) would be required to undergo appropriate design-level geotechnical evaluations prior to final design and construction. Implementing the regulatory requirements in the CBC and local ordinances, and ensuring that all buildings and structures are constructed in compliance with the law is the responsibility of the project engineers and building officials. As described in Section 3.5.3, the CBC describes required standards for the construction, alteration, movement, replacement, location, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California. The standards include earthquake design requirements that determine the seismic design category and then describe the structural design requirements. The geotechnical engineer, as a registered professional with the State of California, is required to comply with the CBC and local codes while applying standard engineering practice and the appropriate standard of care for the particular region in California, which, in the case of the proposed project, is the City. The California Professional Engineers Act (Building and Professions Code Sections 6700–6799), and the Codes of Professional Conduct, as administered by the California Board of Professional Engineers and Land Surveyors, provides the basis for regulating and enforcing engineering practice in California. The local building officials are typically with the local jurisdiction (i.e., the City) and are responsible for inspections and ensuring CBC and local code compliance prior to approval of the building permit. In addition and as described in Section 3.5.3, the construction of the oil wells, storage facilities, and pipeline system and utility corridor would be under the permitting, design specifications, and inspection jurisdiction of DOGGR, as summarized in the DOGGR Publication No. PRC10, California Statutes and Regulations for Conservation of Oil, Gas, & Geothermal Resources. Similar to the CBC, the registered professionals designing and constructing the wells, pipelines, and associated infrastructure are required to comply with DOGGR regulations. Finally, as described in Section 2.5.1.3, Pumpkin Patch Site, the proposed project would either remove the landfilled materials at the Pumpkin Patch site and replace those materials with imported fill appropriately placed and compacted to support the proposed structures, or drive piles through the landfill materials that is to reach underlying stable units to support the building foundation. As discussed above, the geotechnical investigations would include recommendations to address geotechnical issues, including seismic shaking. With compliance with the regulatory requirements and the implementation of geotechnical design recommendations as required by Mitigation Measure GEO-1, Implement Geotechnical Recommendations, impacts relative to seismic shaking would be reduced to a less-than-significant level with mitigation for all components of the proposed project.

Operation

Multiple structures would be constructed as part of the proposed project, including an office, warehouse, oil production wells, and associated oil production and storage facilities. Therefore, the proposed project would place people and structures in an area that could experience strong seismic ground shaking.
Non-Oil Production Structures

As previously discussed, the project structures (e.g., buildings and associated infrastructure) to be constructed at the Pumpkin Patch and LCWA sites would be designed to withstand seismic ground shaking during their operation in compliance with the CBC and local building code regulations, and recommendations from site-specific geotechnical investigations, thereby reducing the potential for structural damage and risks to public safety. The parking lot, berms, trail, and restored ecosystem areas would not contain structures that could become irreparably damaged and harmful to persons in the event of strong ground shaking. Finally, although the existing Synergy building to be relocated and repurposed as a visitors center and the building would not be structurally changed, the existing building would be placed on a new foundation constructed using present-day CBC standards that would improve its ability to withstand seismic shaking. Impacts relative to non-oil production structures regarding ground shaking from seismic events during operation of the project would be less than significant.

Oil Production Structures

As discussed in Section 3.5.3, DOGGR regulations include design specifications for the wells, pipelines, storage tanks, and containment facilities discussed in Chapter 2, Project Description, along with routine inspections of the operations of oil and gas wells, storage tanks, pipelines, and associated infrastructure. Wells are required to have conductor casings that protect the inner well casing from seismic damage and seal off shallower depth intervals to prevent oil and produce water from entering shallower non-oil producing zones such as aquifers with beneficial uses such as drinking water. The wells, well heads, and pipelines would be constructed with pressure-sensing equipment and shutoff valves that would automatically shut off and isolate wells and pipelines should a seismic event damage wells or pipelines. The wells and well heads would be constructed in well cells that would contain oil and produced water in the event of leaks or damage from a seismic event. The storage tanks would be constructed with leak detection equipment and within secondary containment structures. In addition, and as previously discussed, the proposed pipelines, electrical lines, and control cables that would run from the LCWA site across the City Property site and to the Pumpkin Patch site were evaluated for potential displacement or damage in the event of a seismic event. The study identified specific seismic design elements to accommodate the anticipated maximum amount of displacement and minimize the risk of damage. The required design specifications would reduce the risk of damage to the oil production wells, associated infrastructure, workers, and the environment from seismic events to a less-than-significant level.

Mitigation Measure

Mitigation Measure GEO-1 would apply to all project components.

**Mitigation Measure GEO-1: Implement Geotechnical Recommendations.** The Applicant shall prepare final geotechnical investigations for the following project components:

- Visitors center on the Synergy Oil Field site;
- Building on Pumpkin Patch site;
- All well cellars on the Pumpkin Patch and LCWA sites; and
- All tank battery areas on the Pumpkin Patch and LCWA sites.

The geotechnical investigations shall provide recommendations as necessary to address relevant geotechnical issues such as active faults, seismic shaking, seismic-related ground failure including liquefaction, and other soil stability issues including expansive soils, as needed. These types of issues
are addressed through compliance with the CBC, which requires geotechnical investigations to identify geotechnical hazards along with recommendations to reduce the identified risks. Risks from seismic shaking of structures such as the building to be constructed on the Pumpkin Patch site shall be reduced by designing the structures to withstand the anticipated maximum level of seismic shaking. The preliminary geotechnical investigation for the Pumpkin Patch site estimates the Maximum Credible Earthquake of 7.0 magnitude would result in a PGA of 0.604 g (KCG 2016a). Damage from seismic shaking of structures is reduced by designing buildings capable of withstanding or accommodating strong ground motion by using various bracing and anchoring techniques. Damage from soils susceptible to liquefaction can be addressed by driving piles through susceptible materials; conditioning the soils by deep soil mixing, jet or pressure grouting, or dynamic compaction techniques; or by removing the susceptible soils. Damage from placing structures on unstable materials (e.g., the landfill materials on the Pumpkin Patch site) can be addressed by driving piles through unstable materials into underlying stable units or by removing the susceptible soils and replacing the materials with properly compacted imported fill. Damage from expansive soils can be addressed by removing and replacing expansive soils with imported non-expansive fill, or with proper mixing and grading of site materials.

**Significance Determination:** Less than Significant with Mitigation.

**Impact GEO-3:** The project would not expose people or structures to potential substantial adverse effects as a result of seismic-related ground failure, including liquefaction. (Less than Significant with Mitigation)

The potential for liquefaction is higher in areas composed of granular soils with a shallow depth to groundwater. The potential damaging effects of liquefaction include differential settlement, loss of ground support for foundations, ground cracking, heaving and cracking of structural slabs due to sand boils, and buckling of the ground surface due to liquefaction-induced ground displacement. Without appropriate design measures, the placement of structures on such soils could place the public at risk of injury or structures at risk of damage. The impact from induced seismic activity caused by oil production was analyzed above in Impact GEO-1, which is less than significant.

**Construction and Operation**

All four individual sites that comprise the project site are located in areas that are susceptible to liquefaction; thus, liquefaction could damage structures during construction or operations, and place the safety of workers or the public at risk; however, as discussed above in Impact GEO-2, project structures would be designed to withstand seismic ground shaking and seismic-related ground failures in accordance with the CBC, DOGGR, and local building code regulations and recommendations from site-specific geotechnical investigations, thereby reducing the potential for structural damage and risks to workers and public safety. This would include the new foundation that the existing Synergy office building would be placed on and repurposed as a visitors center. The required geotechnical investigations (see Section 3.5.3, CBC and DOGGR regulations) would provide design recommendations to reduce the risk of damage from seismic-induced liquefaction in accordance with these standards and regulations. For example, the preliminary geotechnical investigations for the Pumpkin Patch and LCWA sites, where buildings would be constructed, recommend employing ground improvement techniques or more resistant foundations systems, such as deep foundations such as continuous
flight auger shafts (i.e., the pile is poured into the borehole) or driven piles (KCG 2016a, 2016b). Flexible piping for utilities and production pipelines may also be required. Given the limited areas affected, ground improvement methods consisting of pressure grouting is recommended in areas where the liquefaction induced settlement is greater than what can be accommodated by structural design, with structural design techniques utilized where the amount of differential liquefaction settlement can be tolerated. The parking lot, berms, trail, and restored ecosystem areas would not contain structures that could become irreparably damaged and harmful to persons in the event of ground shaking but would also be designed in accordance with regulatory requirements. As discussed above, the geotechnical investigations would include recommendations to address geotechnical issues, including liquefaction. With implementation of standard engineering practices and standard construction methods, compliance with CBC, DOGGR, and local regulations for conducting geotechnical investigations, and the implementation of the design recommendations from the geotechnical investigations as required by Mitigation Measure GEO-1, Implement Geotechnical Recommendations, ground failure impacts such as seismic-induced liquefaction would be reduced to a less-than-significant level with mitigation for all components of the proposed project.

**Mitigation Measures:** Mitigation Measure GEO-1 would apply.

**Significance Determination:** Less than Significant with Mitigation.

### Impact GEO-4: The project would not expose people or structures to potential substantial adverse effects as a result of seismic-induced landslides. (Less than Significant)

**Construction and Operation**

The project area has a relatively flat topography. Based on a review of aerial photographs and available geotechnical reports and topographic conditions, no landslides are present on or at a location that could impact the project site. The proposed project facilities would not alter the topography so substantially as to introduce the potential for landslides to occur on site. Therefore, construction and operational impacts pertaining to landslides would be less than significant.

**Mitigation Measures:** None required.

**Significance Determination:** Less than Significant.

### Impact GEO-5: The project would not result in substantial soil erosion or the loss of topsoil. (Less than Significant)

Project construction would involve localized ground disturbance activities (e.g., grading, excavation, drilling, and the construction of structures and pipelines) associated with the construction of new wells, the plugging and abandonment of unproductive wells, and the construction of associated buildings and infrastructure.

**Construction**

Because the overall footprint of construction activities would exceed 1 acre, the proposed project would be required to comply with the NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities (Order 2009-0009-DWQ, NPDES No. CAS000002; as amended by Orders 2010-0014-DWQ and 2012-006-DWQ) (Construction General Permit), and the Long Beach Storm
Water Management Program Manual, all of which are described above in Section 3.5.3. These state and local requirements were developed to ensure that stormwater is managed and erosion is controlled on construction sites. The Construction General Permit requires preparation and implementation of a SWPPP, which requires applications of BMPs to control runon and runoff from construction work sites. The BMPs would include, but would not be limited to, physical barriers to prevent erosion and sedimentation, construction of sedimentation basins, limitations on work periods during storm events, use of infiltration swales, protection of stockpiled materials, and a variety of other measures that would substantially reduce or prevent erosion from occurring during construction. The Long Beach Storm Water Management Program Manual, similar to the SWPPP, requires implementation of temporary construction and permanent post-construction erosion control measures for construction sites of all sizes. The applicable erosion control ordinances restrict grading activities during winter months and require preparation of an erosion control plan prior to issuance of building permits. With compliance with the regulations discussed above, impacts associated with soil erosion during construction would be less than significant for all project components.

Although all of the four individual sites that comprise the project site are entirely within disturbed areas, the construction activities would be purposely designed to retain and restore what topsoil there is and reuse that soil to restore the ecosystem. As discussed in Chapter 2, Project Description, soil at the Synergy Oil Field site would be rearranged for habitat restoration. No topsoil would be exported off site unless the topsoil has been contaminated with petroleum hydrocarbons above action levels requiring off-site disposal. At the City Property site, some fill would be imported to build a berm to protect the aboveground pipeline and utilities that would cross the eastern portion of the site; no topsoil would be exported. At the Pumpkin Patch site, the buried landfill materials may be excavated and removed, requiring the import of clean fill for the excavation; no existing clean fill or topsoil would be exported. If removal of the landfill is not necessary, approximately 21,000 cubic yards of soil would be graded and approximately 19,000 cubic yards of soil would be exported off site. The LCWA site was previously raised by the placement of imported fill; no native topsoil is present. Therefore, there would be no impacts related to the loss of topsoil.

**Operation**

The proposed project would reconnect Steamshovel Slough with the marshplain to the south, which would increase the amount of water moving on the site with the tides, and could in turn cause erosion. In a healthy and properly functioning marsh system, tidal channels deposit or scour in response to the size of the tidal prism that the channels convey. When the tidal prism (the volume of water moving during a tidal cycle) increases, tidal channels scour to accommodate the additional flow. Since the proposed project would increase the tidal prism by allowing the tides to flood the marshplain to the south of the slough, the slough is expected to experience some erosion; however, hydraulic modeling showed that the increased velocities in the slough due to the proposed project would not be high enough to cause wide-spread erosion, nor would they require erosion and/or bank protection (M&N 2017). After some initial channel adjustment, erosion during typical tides is expected to be minimal.

In a stable estuary, mature marshes remain in a dynamic equilibrium between erosional and depositional processes. The marsh vegetation and its root structures help hold sediments in place, so the marsh would be expected to capture sediment running onto the site, reducing erosion.

The Synergy Oil Field, Pumpkin Patch, and LCWA sites would be required to comply with the Long Beach MS4 Permit and would be integrated into the city stormwater system. In addition, all aboveground structures
with the exception of new wells and areas of well removal would be required to comply with the City of Long Beach LID requirements and the LID Plan prepared for the Pumpkin Patch site, LCWA site, and visitors center (Wilson Mikami 2017). The LID plan describes the BMPs that would control surface water such that erosion would not occur. With compliance with the regulations discussed above, impacts associated with soil erosion and loss of topsoil during operations would be less than significant for all project components.

Mitigation Measures: None required.

Significance Determination: Less than Significant.

Impact GEO-6: The project would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. (Less than Significant with Mitigation)

Construction and Operation

As discussed in Impact GEO-4, there is no identified risk for landslides or lateral spreading within the project area. All project components would be located in relatively flat to gently-sloping topography and would, therefore, have a low to no susceptibility to seismically or non-seismically induced landslides or lateral spreading. Therefore, there would be no impact related to landslides or lateral spreading.

As discussed in Section 3.5.2, subsidence is commonly associated with severe, long-term withdrawal of groundwater and/or oil in excess of recharge that eventually leads to overdraft of the aquifer or production zone. This is the reason that oil production operations re-inject the groundwater from oil production back into the production zone to prevent subsidence. The proposed project would continue the current practice of returning the groundwater to the depth levels from which it was extracted, reducing the potential for subsidence (BOMP 2017c).

The geotechnical and environmental studies for the sites concluded that the Pumpkin Patch and LCWA sites would have the potential for significant collapse or subsidence due to the uncertain nature of the landfilled materials buried at the site; however, as discussed above for Impact GEO-2, the proposed structures for the Pumpkin Patch and LCWA sites would be required to comply with the CBC (see Section 3.5.3, CBC regulations), which would require the design to undergo appropriate design-level geotechnical evaluations prior to final design and construction. If necessary, for the Pumpkin Patch site, this may include removing the landfilled materials and replacing those materials with imported fill appropriately placed and compacted to support the proposed structures as described above. With implementation of standard engineering practices and standard construction methods, compliance with CBC and local regulations for conducting geotechnical investigations, and the implementation of the design recommendations from the geotechnical investigations as required by Mitigation Measure GEO-1, Implement Geotechnical Recommendations, ground failure impacts from unstable geologic units would be reduced to a less-than-significant level with mitigation for all components of the proposed project.

As discussed above for Impact GEO-3, the design of structures would be required to undergo appropriate design-level geotechnical evaluations prior to final design and construction, which would include providing recommendations to address non-seismically induced liquefaction. With compliance with the regulatory requirements, impacts relative to non-seismically induced liquefaction would be less than significant with mitigation.
Mitigation Measures: Mitigation Measure GEO-1 would apply.

Significance Determination: Less than Significant with Mitigation.

Impact GEO-7: The project could be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property. (Less than Significant with Mitigation)

As previously noted, the CBC, based on the IBC and the now defunct UBC, no longer includes a Table 18-1-B. Instead, CBC Section 1803.5.3 describes the criteria for analyzing expansive soils.

As discussed in the setting, the geotechnical investigation of the alluvial materials on the Pumpkin Patch and LCWA sites concluded the materials are considered to have low to moderate expansion potential. A geotechnical investigation for expansive soils has yet not been conducted for the Synergy Oil Field but would be prepared for the design of the new foundation to which the existing office building would be relocated. A geotechnical investigation for the pipeline that would cross the City Property site was conducted to provide pipeline design criteria to enable the pipeline to accommodate movement due to seismic events.

Construction

The structures proposed under the project could be located on soils with a moderate potential for soil expansion; however, until the structures are complete, the potential for damage from expansive soils during construction would be minimal, if any, largely due to the amount of time required for expansive soils to exhibit damage. Therefore, the potential impact during construction would be considered less than significant.

Operation

Buildings, a warehouse, oil storage tanks, and associated infrastructure would be constructed on the Pumpkin Patch and LCWA sites. The existing Synergy office building on the Synergy Oil Field site would be relocated to the southwest portion of the Synergy Oil Field site and placed on a new raised foundation. An oil transmission pipeline and utility corridor would be constructed from the LCWA site across the City Owned Property to the Pumpkin Patch site. The structures could be located on soils with up to a moderate potential for soil expansion, which could damage structures and result in risks to people or structures if not designed appropriately; however, as discussed above for Impact GEO-2, the design of structures would be required to undergo appropriate design-level geotechnical evaluations prior to final design and construction, which would include providing recommendations to address expansive soils, if present. For example, the preliminary geotechnical investigations for the Pumpkin Patch and LCWA sites, where buildings would be constructed, recommended special foundation design including either removal or replacement of on-site soils with non-expansive soil or utilizing stiffer foundations such as post-tensioned or slab on grade foundation systems designed in accordance with the CBC (KCG 2016a, 2016b). With implementation of standard engineering practices and standard construction methods, compliance with CBC and local regulations for conducting geotechnical investigations, and the implementation of the design recommendations from the geotechnical investigations as required by Mitigation Measure GEO-1, Implement Geotechnical Recommendations, ground failure impacts due to expansive soils would be reduced to a less-than-significant level with mitigation for all components of the proposed project.

Mitigation Measures: Mitigation Measure GEO-1 would apply.
Significance Determination: Less than Significant with Mitigation.

3.5.4.4 Cumulative Impacts

The Los Angeles Basin is a seismically active region with a wide range of geologic and soil conditions that can vary greatly within a short distance. Accordingly, geologic, soils, and seismic impacts tend to be site-specific and depend on the local geology and soil conditions. For these reasons, the geographic scope for potential cumulative geologic and seismic impacts consists of the project component locations and the immediate vicinity. The timeframe during which the proposed project could contribute to cumulative geology, seismicity, and soils effects includes the construction and operations phases.

Cumulative Impacts during Project Construction

As described in Impact GEO-5, construction activities have the potential to cause soil erosion and loss of topsoil. If the cumulative projects were constructed at the same time, the erosion effects could be cumulatively significant if appropriate measures were not taken; however, the state Construction General Permit and the Long Beach Storm Water Management Program would require each cumulative project to prepare and implement a SWPPP. The SWPPPs would describe BMPs to control runoff and prevent erosion for each project. Through compliance with the Construction General Permit, the potential for erosion impacts would be reduced to less-than-significant levels. The Construction General Permit has been developed to address cumulative conditions arising from construction throughout the state, and is intended to maintain cumulative effects of projects subject to this requirement below levels that would be considered significant. For example, two adjacent construction sites would each be required to implement BMPs to reduce and control the release of sediment and/or other pollutants in any runoff leaving their respective sites, including from erosion. The runoff water from both sites would be required to achieve the same action levels, measured as a maximum amount of sediment or pollutant allowed per unit volume of runoff water. Thus, even if the runoff waters were to combine after leaving the sites, the sediments and/or pollutants in the combined runoff would still be at concentrations below action levels and would not be cumulatively considerable (less than significant).

Similarly, the impacts of the proposed project combined with other cumulative projects within the region would not cause a significant cumulative impact related to soil erosion and the proposed action’s contribution to cumulative impacts on soil erosion would not be cumulatively considerable (less than significant).

Until the construction of structures has been completed, there would be no impacts from seismic events (e.g., fault rupture, seismic shaking, seismically induced ground failures such as liquefaction, lateral spreading, or landslides) or non-seismically induced ground failures (e.g., landslides, lateral spreading, subsidence, liquefaction, collapse, or expansive soil) due largely to the relatively short period that construction would take place and the likelihood of a seismic event occurring at that time. Therefore, the cumulative impacts during construction would not be cumulatively considerable (less than significant).

Cumulative Impacts during Project Operations

Impacts from seismic events (e.g., fault rupture, seismic shaking, seismically induced ground failures such as liquefaction, lateral spreading, or landslides) or non-seismically induced ground failures (e.g., landslides, lateral spreading, subsidence, liquefaction, collapse, or expansive soil) tend to be confined to each given site due to varying conditions and distance to epicenter. In addition, each cumulative project would also be required to comply with the requirements of the CBC and local building codes, which would require
geotechnical investigations to identify potential geotechnical issues and provide recommendations to reduce or eliminate the risks. Each cumulative project would be required to conduct geotechnical investigations and develop recommendations to address geotechnical hazards. With compliance with applicable regulations and the implementation of mitigation measures such as Mitigation Measure GEO-1, Implement Geotechnical Recommendations, the cumulative impacts would be reduced and would not be cumulatively considerable (less than significant).

Upon completion of the proposed project and any nearby cumulative projects, each project would be required to comply with the Long Beach MS4 Permit, Long Beach LID Manual, and various sections of the LBMC, all of which contain requirements to control surface water runoff and erosion. Similar to the discussion above of how SWPPPs would control runoff and prevent erosion for cumulative construction impacts, because each cumulative project would be required to comply with the same regulations and to the same action levels, the impacts would not be cumulatively considerable (less than significant with mitigation).

### 3.5.5 References


———. 2016b. *Phase I Environmental Site Assessment for LCWA Property North of 2nd Street and East of Studebaker Road, County of Los Angeles, Long Beach, California*, May.


CH2M Hill. 2004. Phase II Environmental Site Assessment Alamitos EPTC Parcel 3-4, Located at NE Corner of the Intersection of North Studebaker Road and Westminster Avenue, Long Beach, California, December.


——. 2016c. Limited Alquist-Priolo Fault Zone Evaluation, Synergy Oil Field Site, 6433 E. Second Street, City of Long Beach, California, October 27.


Rincon Consultants, Inc. 2015a. Phase I Environmental Site Assessment, 154-Acre Property, Pacific Coast Highway, Long Beach, California, May 1.


Virginia Polytechnic Institute and State University (Virginia Tech [VT]). 2013. Liquefaction-Induced Lateral Spreading.


