3.2 Geology and Soils

3.2.1 Overview

This section describes the existing geology and soil conditions and applicable laws and regulations associated with geology and soils, as well as an analysis of the potential effects resulting from implementation of the proposed project. Information contained in this section is summarized from the Albus-Keefe & Associates, Inc. *Preliminary Geotechnical Investigation* (May 9, 2019) (Appendix C).

3.2.2 Environmental Setting

Regional Geologic Setting

The project site is located in the Peninsular Ranges Geomorphic Province, near the western edge of the Los Angeles Coastal Plain and at the far northwestern extension of the Signal Hill uplift. Signal Hill is a surface expression of the northwesterly Newport-Inglewood structural fault zone. Signal Hill and the project vicinity are generally underlain by thousands of feet of sediments that rest above metamorphic basement rock. The current surface expression of the area is Holocene- and Pleistocene-age sediments. These sediments are typically comprised of artificial fill materials, colluvium, and alluvium.

Geologic Units and Local Setting

Artificial Fill

Artificial fill materials are present throughout most of the project site, with the most extensive concentration in the lower westerly margin of the project site within the former drainage course. The upper easterly portion of the project site generally consists of fine-grained silty sands and sands that are brown and olive gray in color, dry to moist, and loose. The fill ranges in thickness from nil to 14 feet. The lower westerly portion of the project site generally consists of mixtures of sands, silts, and clays, in various shades of brown and gray, dry to moist, and loose to very dense or soft to very stiff. The fill in this location is up to as much as 25 to 30 feet in thickness.

Additionally, construction debris was located throughout the project site, with the majority of debris found at 12 inches or less below ground surface. In the southwesterly portion of the project site, concrete and asphalt debris up to 3 feet in size were encountered along the base of the fill.

Residual Soil

Residual soil materials (or top soil) were observed on the bedrock material in locations where remnants of the original natural ground surface have been preserved. The residual soil materials generally consist of fine-grained silty sands that are brown in color, damp, loose to medium dense, and porous containing fine roots. This unit varies from 1 to 2 feet thick.

Alluvium

Alluvium deposits are associated with the former drainage located in the lower westerly area of the project site. The material generally consists of thinly-interfingered layers and lenses of olive gray to black, fine-grained sands, silty sands, clayey sands, sandy silts, sandy clays, organic silts, lean clays,

and fat clays. The material was damp to wet, medium dense to dense, or soft to very stiff. Alluvium materials are up to 30 inches in thickness.

Bedrock – San Pedro Formation

The San Pedro Formation is a near-shore marine deposit that underlies the entire project site. This formation consists of gray to pale yellow, slightly micaceous, silty sandstone to sandstone that is dry to damp, slightly friable, and moderately hard.

Geologic Hazards

Faulting and Seismicity

The California Geological Survey (CGS) defines an active fault as a fault showing evidence for activity within the last 11,000 years. The project site is not located within a State of California Earthquake Fault Zone (EFZ; formerly known as an Alquist-Priolo Special Studies Zone), and there are no known active, potentially active, or inactive faults located at the project site. The nearest known fault is the Cherry Hill fault segment of the Newport-Inglewood fault zone (south Los Angeles Basin section-southern), which is located approximately 900 feet southwest of the project site.

Liquefaction, Lateral Spreading, and Seismically Induced Settlement

Liquefaction can occur when a site is located in a zone with seismic activity, on-site soils are cohesionless, groundwater is encountered within 50 feet of the surface, and soil relative densities are less than about 70 percent. The western half of the project site is located in a liquefaction zone that requires investigation. Liquefaction occurs when granular soil below the water table is subjected to vibratory motions, such as those produced by earthquakes. With strong ground shaking, an increase in pore water pressure develops, as the soil tends to reduce in volume. If the increase in pore water pressure is sufficient to reduce the vertical effective stress (suspending the soil particles in water), the soil strength decreases, and the soil behaves as a liquid (similar to quicksand). Liquefaction can produce excessive settlement, ground rupture, lateral spreading, or failure of shallow bearing foundations.

Expansive Soil

Expansive soils are generally plastic clays that can undergo a substantial increase in volume, with an increase in moisture content, and a substantial decrease in volume, with a decrease in moisture content. Expansive soils can cause uplift pressures that can lead to structural damage. Soils in the project site have reported values of Expansion Index up to 32.

3.2.3 Regulatory Framework

Table 3.2-1 identifies and summarizes laws, regulations, and plans relative to geology and soils.

Table 3.2-1. Applicable Laws, Regulations, and Plans for Geology and Soils

Laws, Regulation, or Plan	Description
Federal	
Earthquake Hazards Reduction Act	In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the U.S. through the establishment and maintenance of an effective earthquake hazards reduction program. To accomplish this goal, the act established the National Earthquake Hazards Reduction Program, which was further refined by the National Earthquake Hazards Reduction Program Act.
Uniform Building Code	The Uniform Building Code is published by the International Conference of Building Officials and forms the basis for CBC, as well as approximately half of the state building codes in the U.S. It has been adopted by the California Legislature to address the specific building conditions and structural requirements for California, as well as provide guidance on foundation design and structural engineering for different soil types.
State	
Alquist-Priolo EFZ Act	The Alquist-Priolo EFZ Act (California PRC Sections 2621–2630) was passed into law following the destructive February 9, 1971, San Fernando earthquake, which was associated with extensive surface fault ruptures that damaged numerous structures. The act provides a mechanism for reducing losses from surface fault rupture on a statewide basis. The intent of the act is to ensure public safety by prohibiting the siting of most structures for human occupancy across traces of active faults that constitute a potential hazard to structures from surface faulting or fault creep.
CBC	California provides minimum standards for building design through the CBC (Title 24). The 2016 California codes became effective January 1, 2017. With the shift from seismic zones to seismic design, the CBC philosophy has shifted from “life safety design” to “collapse prevention,” meaning that structures are designed for prevention of collapse for the maximum level of ground shaking that could reasonably be expected to occur at a site.
PRC	The PRC includes regulations for paleontological resources as described below: • PRC Section 5097.5: Provides for the protection of paleontological resources and prohibits the removal, destruction, injury, or defacement of paleontological features on any lands under the jurisdiction of state or local authorities • PRC Section 30244: Requires reasonable mitigation for impacts on paleontological resources that occur as a result of development
Seismic Hazard Mapping Act	The California Department of Conservation provides guidance to the Seismic Hazards Mapping Act, which aims to reduce the threat of seismic hazard to public health and safety by identifying and mitigating seismic hazards. State, county, and city agencies are directed to utilize such maps in land use and permitting processes. The act also requires geotechnical investigations particular to the site be conducted before permitting occurs on sites within seismic hazard zones.

Table 3.2-1. Applicable Laws, Regulations, and Plans for Geology and Soils

Laws, Regulation, or Plan	Description
State Water Resources Control Board Construction Storm Water Program	Created in 1972 by the Clean Water Act, the NPDES permit program is authorized to state governments by the U.S. EPA to perform permitting, administrative, and enforcement aspects of the program. Construction activities that disturb 1 acre or more of soil are required to obtain coverage under the General Permit for Discharges of Storm Water Associated with Construction Activity Construction General Permit Order 2009-0009-DWQ (as amended by Order 2010-0014-DWQ and Order 2012-0006-DWQ). Construction activities subject to compliance include clearing, grading, and excavating. Applicants of regulated construction activities are required to file Notice of Intent and Permit registration Documents with the State Water Resources Control Board. Applicants must prepare a Storm Water Pollution Prevention Plan and demonstrate conformance with applicable construction BMPs.
Local	
LBMC	Chapter 18.04 Permits outlines the various permit requirements within the City of Long Beach. Section 18.04.010 describes the permits required to be obtained from the city prior to construction, including building permits, grading permits, electrical permits, plumbing permits, and mechanical permits. Chapter 18.40 Building Code outlines the City Council adopted building codes and describes the reinforcement of the CBC within the city and any exceptions to the CBC. Chapter 18.68 Earthquake Hazard Regulations 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 also identifies the minimum standards for structural seismic resistance established primarily to reduce the risk of life loss or injury.
Long Beach General Plan	Seismic Safety Element includes advance planning recommendations for land use including giving priority to low risk type projects such as low rise buildings and open space in areas of known seismic hazards. Additionally, the Seismic Safety Element also includes immediate action recommendations for structure and design, including discouragement of new unfavorable site/structure combinations and no structures for human occupancy within the Alquist-Priolo Special Studies Zones. The Conservation Element includes soils management goals including minimizing activities which will have a critical or detrimental effect on geologically unstable areas and soils subject to erosion.

Notes:
BMP=best management practices; CBC=California Building Code; EFZ=Earthquake Fault Zone; LBMC=Long Beach Municipal Code; NPDES=National Pollutant Discharge Elimination System; PRC=Public Resources Code; U.S. EPA=United States Environmental Protection Agency

3.2.4 Analysis of Impacts

Methodology

Potential direct and indirect project impacts were identified based on a review of the *Preliminary Geotechnical Investigation* prepared by Albus-Keefe & Associates, Inc., which is included in this EIR as Appendix C. The report included desk-top analysis of the geological conditions, as well as site reconnaissance and field excavations.

Thresholds of Significance

Based on CEQA Guidelines Appendix G, project impacts related to geology and soils are considered significant if any of the following occur:

a) Directly or indirectly cause to potential substantive adverse effects, including the risk of loss, injury, or death involving:

   i. 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.

   ii. Strong seismic ground shaking

   iii. Seismic related ground failure, including liquefaction

   iv. Landslides

b) Result in substantial soil erosion or the loss of topsoil

c) 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

d) Be located on expansive soil, as defined in the latest Uniform Building Code, creating substantial direct or indirect risks to life or property

e) 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

f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature

As discussed in the IS (Appendix A), criteria (a.i.), (a.iv.), (b), (e), and (f) would result in no impact or a less than significant impact and therefore are not included in the analysis below.

Impact Analysis

Threshold (a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving: (ii.) strong seismic ground shaking or (iii.) seismic-related ground failure, including liquefaction.

There are no known active or potentially active faults that have been mapped at the site, and the site is not located within a State of California EFZ. However, an EFZ is located about 600 feet southwest of the project site (California Department of Conservation 2016a). The project site does have the potential to be exposed to strong seismic shaking. Impacts are potentially significant.

Project facilities would need to be designed consistent with the city's existing construction ordinances and the California Building Code (CBC) in order to minimize hazards during a seismic event. The CBC includes standards related to soils and foundations, structure design, building materials, and structural testing and inspections.

Implementation of **Mitigation Measure GEO-1** requires compliance with the recommendations in the *Preliminary Geotechnical Report* and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans. In addition, the project would be required to be constructed in compliance with the LBMC and CBC. With implementation of **Mitigation Measure GEO-1** and mandatory compliance with the LBMC and CBC, impacts would be less than significant.

The project site is partially within an area mapped by CGS as liquefiable. Geotechnical calculations indicate that some soils below the site are susceptible to liquefaction during a strong ground motion event. Impacts are potentially significant.

The effects of liquefaction can be properly mitigated with appropriate design. Based on the State of California Special Publication 117A, hazards from liquefaction should be mitigated to the extent required to reduce seismic risk to "acceptable levels." The acceptable level of risk means, the "level that provides reasonable protection of the public safety" (CCR Title 14, Section 3721 (a)). Protection of public safety does not require that structures be resistant to cracking or general distress due to differential movements. As such, a greater allowance for differential movement during liquefaction events is acceptable compared with the design requirements for static conditions. The use of well reinforced foundations, such as post-tensioned slabs, spread footings tied together with grade beams, or mat foundations, have been proven to adequately provide basal support during liquefaction events comparable to the predicted site event. A predicted site event assumes a magnitude of 6.8 and a distance of 4.6 miles from the seismic source. Implementation of **Mitigation Measure GEO-1**, which requires compliance with the recommendations in the *Preliminary Geotechnical Report* and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans, would reduce potential significant impacts to a level less than significant.

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

As discussed in the IS, Table VII. Geology and Soils, Environmental Issue Area (a.iv.) (Appendix A), the project site is not within a landslide zone. As discussed under Threshold (a) above, the project site is partially within an area mapped by CGS as liquefiable. Liquefaction can produce excessive settlement, ground rupture, lateral spreading, failure of shallow bearing foundations, or some ground

subsidence. Based on the analysis in the *Preliminary Geotechnical Report*, the existing artificial fill materials and the residual soil materials in this area are generally loose and porous, which means these materials would likely be prone to collapse upon wetting and settlement when subjected to the weight of additional fills and foundation loads. This anticipated settlement would likely be in excess of the tolerable limits of the proposed structure. Impacts are potentially significant.

The effects of unstable soil can be properly mitigated with appropriate design. Removal and recompaction of the artificial fill materials and the residual soil materials in this area would mitigate these effects. The depth to which removal of existing artificial fills would be needed should be determined by a geotechnical consultant during site grading based on potholing and moisture density testing, as described in the *Preliminary Geotechnical Report*. Implementation of **Mitigation Measure GEO-1**, which requires compliance with the recommendations in the *Preliminary Geotechnical Report*, and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans, would reduce potential significant impacts to a level less than significant.

Threshold (d) Be located on expansive soil, as defined in the latest Uniform Building Code, creating substantial direct or indirect risk to life or property.

The Preliminary Geotechnical Report describes the on-site soils as low to medium expansion potential with reported values on the Expansion Index of up to 32. Changes in volumetric soil changes can cause excessive movement in foundations, pavement, and flatwork. Impacts are potentially significant. The *Preliminary Geotechnical Report* provides testing and remediation recommendations that would mitigate the effects of potentially expansive soils. Supplemental testing for soil expansion would be required subsequent to rough grading and prior to construction of foundations and other concrete work to develop final recommendations for mitigation of expansive soils.

Implementation of **Mitigation Measure GEO-1** requires compliance with the recommendations in the *Preliminary Geotechnical Report* and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans and would reduce potential significant impacts to a less than significant level.

Cumulative Impacts

Geologic and soil conditions are typically site specific and can be addressed through appropriate engineering practices. Cumulative impacts with regards to geologic resources would be considered significant if the proposed project would be impacted by geologic hazards(s) and if the impact could combine with off-site geologic hazards to be cumulatively considerable. However, there are no unique geological characteristics on the project site that would pose this type of hazard. Geologic and soil conditions on the project site would result in a significant geology/soils impact that can be mitigated to less than significant. The proposed project's incremental effects are not cumulatively considerable. Geologic conditions in the Southern California region would essentially be the same regardless of the amount of development, and the cumulative geologic impact is considered less than significant. No significant cumulative impact on geology/soils would occur.

Mitigation Measures

GEO-1 **Incorporation of and Compliance with the Recommendations in the Preliminary and Final Geotechnical Report.** The project shall be constructed in conformance with the recommendations included in the *Preliminary Geotechnical Investigation* prepared by Albus-Keefe & Associates, Inc. (Appendix C) and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans. The City of Long Beach shall confirm compliance with all recommendations in the *Preliminary Geotechnical Report* and Final Geotechnical Report prior to issuance of building permits. Recommendations include, but are not limited to, the following:

CBC Compliance:

- Design and construction shall be done in accordance with current CBC requirements in order to address any issues related to potential ground shaking at the site.

Recommendations for a well-reinforced foundation system:

- Additional testing of site soils shall be performed after site grading to confirm the expansion potential.
- Foundations shall be designed for total differential static settlement up to 1 inch and 0.5 inch over 30 feet.
- An allowable bearing value shall be used.
- Lateral bearing for footings shall be determined.
- Exterior continuous building footings shall be founded at a minimum depth of 18 inches.
- Foundation excavations shall be observed by the project geotechnical consultant prior to placement of forms or reinforcement.

Recommendations to limit soil expansion:

- Earthwork and grading shall be performed in accordance with applicable requirements of California Occupational Safety and Health Administration and the Grading Codes of the City of Long Beach.
- All existing artificial fills shall be removed to a maximum depth of 10 feet below existing ground surface.
- Materials excavated from the site may be used as fill, provided they are free of deleterious materials and particles greater than 6 inches in maximum dimension.
- Asphalt and concrete materials greater than 6 inches shall be reduced in maximum dimension and incorporate within the fill materials, provided they are mixed with granular materials and spread throughout the fill to eliminate nesting.
- Construction of surcharge fills placed 15 feet above the proposed finish grades in selected areas is recommended.

- Edges of surcharge fills may be sloped 1.5:1 where space permits. Where insufficient room is present for slopes, a wire basket and geofabric system would be required.
- Surcharge fills shall remain in place until the remaining settlement due to future final grades.
- Surcharge fills shall be monitored by instruments prior to and after placement of fills above the current grades.

Level of Significance after Mitigation

Implementation of **Mitigation Measure GEO-1** would reduce potential significant impacts to a level less than significant by requiring the incorporation of and compliance with the recommendations in the Preliminary Geotechnical Report and the Final Geotechnical Report that will be prepared in conjunction with final detailed project plans, including consistency with the LBMC and CBC.

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