5.5 GEOLOGY AND SOILS

This section of the Draft Environmental Impact Report (DEIR) evaluates the potential for implementation of the Villages at Cabrillo Specific Plan (Specific Plan) to impact geological and soil resources, paleontological resources, or unique geologic features in the City of Long Beach. The analysis in this section is based in part on the following sources:

- *Cultural and Paleontological Resources Assessment Report for the Century Villages at Cabrillo*, Cogstone, November 2020 ("Cultural and Paleontological Resources Assessment Report").
- *Geotechnical Engineering Investigation Proposed Residential Complex Century Village at Cabrillo (CVC) Phase VI*, Geotechnologies, Inc., November 2019 ("Geotechnical Investigation").

Complete copies of these technical reports are included in Appendix D and E of this DEIR, respectively.

5.5.1 Environmental Setting

5.5.1.1 REGULATORY BACKGROUND

State and local laws, regulations, plans, or guidelines related to geology and soils that are applicable to the Specific Plan are summarized below.

Federal

Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act was enacted in 1997 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." To accomplish this, the act established the National Earthquake Hazard Reduction Program (NEHRP), which refined the description of agency responsibilities, program goals, and objectives. NEHRP's mission includes improved understanding, characterization, and prediction of hazards and vulnerabilities, improvement of building codes and land use practices, risk reduction through post-earthquake investigations and education, development and improvement of design and construction techniques, improvement of mitigation capacity, and accelerated application of research results. NEHRP designates the Federal Emergency Management Agency as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Programs under NEHRP help inform and guide planning and building code requirements such as emergency evacuation responsibilities and seismic code standards.

Uniform Building Code

Published by the International Conference of Building Officials, the Uniform Building Code (UBC) provides standards for the development of better building construction and greater safety to the public. The UBC was updated every three year with its final publication in 1997. The UBC provides the basis for developing the

California Building Code and contains provisions for administrative, fire- and life-safety and field inspection, structural, and engineering design.

State

California Alquist-Priolo Earthquake Fault Zoning Act

The California Alquist-Priolo Earthquake Fault Zoning Act was signed into state law in 1972, with its primary purpose to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. This act (or state law) was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. The act requires the State Geologist (California Geologic Survey, CGS) to delineate regulatory zones known as "earthquake fault zones" along faults that are "sufficiently active" and "well defined" and to issue and distribute appropriate maps to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Pursuant to this act and as stipulated in Section 3603(a) of the California Code of Regulations, structures for human occupancy are not permitted to be placed across the trace of an active fault. The act also prohibits structures for human occupancy within 50 feet of the trace of an active fault, unless proven by an appropriate geotechnical investigation and report that the development site is not underlain by active branches of the active fault, as stipulated in Section 3603(a) of the California Code of Regulations. Furthermore, the act requires that cities and counties withhold development permits for sites within an earthquake fault zone until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting, as stipulated in Section 3603(d) of the California Code of Regulations.

Seismic Hazard Mapping Act

The Seismic Hazard Mapping Act was adopted by the state in 1990 for the purpose of protecting the public from the effects of nonsurface fault rupture earthquake hazards, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. The CGS prepares and provides local governments with seismic hazard zones maps that identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures.

California Building Code

Current law states that every local agency enforcing building regulations, such as cities and counties, must adopt the provisions of the California Building Code (CBC) within 180 days of its publication. The publication date of the CBC is established by the California Building Standards Commission, and the code is under Title 24, Part 2, of the California Code of Regulations. The CBC provides minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground shaking with a specified

probability at a site. The 2019 CBC took effect on January 1, 2020, and is codified and incorporated by reference in Chapter 18.40 (Building Code) of the LBMC.

Requirements for Geotechnical Investigations

Requirements for geotechnical investigations are included in CBC Appendix J, Grading, Section J104.3, Geotechnical Reports; additional requirements for subdivisions requiring tentative and final maps and for other specified types of structures are contained in California Health and Safety Code Sections 17953 to 17955 and in CBC Section 1803 (Geotechnical Investigations). Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be conducted 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. CBC Section J106 (Excavations) establishes requirements for inspection and observation during and after grading.

California Public Resources Code

PRC Sections 5097.5 and 30244 require the assessment and management of paleontological resources. Requirements in these statutes include reasonable mitigation of adverse impacts to paleontological resources resulting from development on state lands, defines the removal of paleontological "sites" or "features" from state lands as a misdemeanor, and prohibits the removal of any paleontological "site" or "feature" from State land without permission of the jurisdictional agency.

Local

City of Long Beach Municipal Code

The City adopted the most recent CBC (2019) and California Residential Code (CRC, 2019) by reference, with certain amendments, into Chapter's 18.40 (Building Code) and Chapter 18.41 (Residential Code), respectively, of the LBMC.

City of Long Beach General Plan

The City of Long Beach General Plan Seismic Safety Element outlines the goals and policies required to reduce the loss of life, injuries, damage to property, social and economical impacts resulting from seismic hazards. The 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.

5.5.1.2 EXISTING CONDITIONS

Regional Setting

The Plan Area is in the Los Angeles Basin, a coastal plain at the north end of the Peninsular Ranges Geomorphic Province. The Peninsular Ranges Geomorphic Province is characterized by mountain ranges separated by northwest-trending valleys, and it extends from southwestern California south into Mexico. The Los Angeles Basin is bounded by the Santa Monica Mountains and San Gabriel Mountains on the north, the Santa Ana Mountains on the east, and the Pacific Ocean on the south and west. The Santa Monica Mountains and San Gabriel Mountains are part of the Transverse Ranges Geomorphic Province, an east-west-trending series of steep mountain ranges and valleys extending from Santa Barbara County in the west to central Riverside County in the east.

Local Setting

Geological Conditions

The Plan Area is relatively flat with minor elevation changes as it slopes downwards to the southwest. Most of the Plan Area consists of existing fill and natural alluvium. The geologic units underlying the Plan Area are mapped entirely as late Pleistocene to Holocene young alluvium (unit 2) which was deposited between 126,000 years ago through historic times. Fill was encountered at 2.5 to 3 feet below the existing grade, which consists of sandy silt, silty sand, and sand. Fill soils are yellowish to dark brown, moist, firm, medium dense, and fine grained while natural alluvium soils consist of silty sands, sandy silts, and silty clays and are yellowish to dark drown or gray in color, moist to wet, loose to very dense, and primary finely grained (Geotechnologies 2019).

Groundwater

Groundwater was encountered at depths of 4.5 to 8 feet below existing grade (Geotechnologies 2019). The historical high groundwater levels under the Plan Area is approximately 15 feet below ground surface.

Geologic and Seismic Hazards

Faults

Faults showing evidence of surface displacement within the last 11,000 years are classified as active by the California Geological Survey. The Plan Area is not in an Alquist-Priolo Earthquake Fault Zone, and no evidence of faulting was identified during the Geotechnical Investigation (Geotechnologies 2019). The nearest Alquist-Priolo Earthquake Fault Zone to the Plan Area is the Newport-Inglewood Fault, which is an active fault about 2.4 miles to the northeast (CGS 2020). Other active faults in the region include the Palos Verdes Fault Zone, offshore about 7 miles to the south, and the Whittier Fault about 15 miles to the northeast (CGS 2020).

Historical Earthquakes

There have been no notable earthquakes, of a magnitude of 5.5 or more, affecting the Long Beach region within the last 50 years. The most recent earthquakes closest to the Plan Area were the 1941 Torrance-Gardena Earthquakes which occurred to the northeast and southwest of the Plan Area both having a magnitude of 4.8 (SCEDC 2020a).

Long Beach Earthquake

The Long Beach Earthquake of 1933, which occurred on the Newport-Inglewood Fault and had a magnitude estimated at 6.4, caused 120 deaths and over $50 million in property damage. Severe property damage occurred in Compton, Long Beach, and other cities in the area. Most of the damage was due to land fill, deep water-soaked alluvium or sand, and poorly-designed buildings. Minor disturbances of groundwater, secondary cracks in the ground, and slight earth slumps occurred, but surface faulting was not observed. Along the shore between Long Beach and Newport Beach, the settling or lateral movement of road fills across marshy land caused much damage to the concrete highway surfaces and to approaches to highway bridges.

In Compton, almost every building in a three-block radius on unconsolidated material and land fill was destroyed. In Long Beach, buildings collapsed, houses were pushed from foundations, walls were knocked down, and tanks and chimneys fell through roofs (Geology 2020). Many school buildings were destroyed, but students were not at school when the 5:54 PM quake occurred. The earthquake led to passage of the Field Act regulating construction of public school buildings in California (SCEDC 2020b).

Surface Fault Rupture

Ground rupture due to a fault movement typically results in a small percentage of total impact caused by an earthquake. Due to the distance of the Plan Area to a known active fault (approximately 2.4-miles northeast), the potential for surface fault rupture at the Plan Area is considered low (Geotechnologies 2019).

Seismic Ground Shaking

Horizontal ground acceleration, which frequently results in widespread damage to structures, is estimated as a percentage of g, the acceleration of gravity. The damage that an earthquake will cause to a structure depends on the earthquake's size, location, distance, and depth, the types of rock and soil at the surface of the site, and the type of construction of the structure.

When comparing the sizes of earthquakes, the most meaningful feature is the amount of energy released. Thus, scientists most often consider seismic moment, a measure of the energy released when a fault ruptures. We are more familiar, however, with scales of magnitude, which measure amplitude of ground motion. The energy released by an earthquake is measured as moment magnitude (Mw). The moment magnitude scale is logarithmic; therefore, each one-point increase in magnitude represents a 10-fold increase in amplitude of the waves as measured at a specific location and a 32-fold increase in energy. That is, a magnitude 7 earthquake produces 100 times (10 x 10) the ground motion amplitude of a magnitude 5 earthquake.

Geologic Hazards

Liquefaction and Related Ground Failure

Liquefaction is a process whereby strong earthquake shaking causes sediment layers that are saturated with groundwater to lose strength and behave as a fluid. This subsurface process can lead to near-surface or surface ground failure that can result in property damage and structural failure. If surface ground failure does occur, it is usually expressed as lateral spreading, flow failures, ground oscillation, and/or general loss of bearing strength. Sand boils (injections of fluidized sediment) can commonly accompany these different types of failure.

In order to determine a region's susceptibility to liquefaction, three major factors must be analyzed. These include:

- The intensity and duration of ground shaking.
- The age and textural characteristic of the alluvial sediments. Generally, the younger, less well compacted sediments tend to have a higher susceptibility to liquefaction. Textural characteristics also play a dominant role in determining liquefaction susceptibility. Sand and silty sands deposited in river channels and floodplains tend to be more susceptible to liquefaction and floodplains tend to be more susceptible to liquefaction than coarser or finer grained alluvial materials.
- The depth to the groundwater. Groundwater saturation of sediments is required in order for earthquake induced liquefaction to occur. In general, groundwater depths shallower than 10 feet to the surface can cause the highest liquefaction susceptibility.

The entire Plan Area is within a liquefaction zone as identified in the State of California Seismic Hazard Zones Map (Long Beach Quadrangle) (CGS 1999). Additionally, liquefaction analysis performed during the Geotechnical Investigation indicated that soil layers at various depths below the ground surface would be susceptible to liquefaction (Geotechnologies 2019). The Standard Penetration Test concluded that liquefaction settlements range from 5.58 to 7.34 inches while the Cone Penetration Test concluded that liquefaction settlements range from 5.47 to 7.18 inches (Geotechnologies 2019).

Lateral Spreading

Lateral spreading is a form of seismic ground failure due to liquefaction in a subsurface layer. Sediments with corrected (NI)60 values greater than 15 are generally not susceptible to lateral spreading. Based on the sediments encountered at the Plan Area, the upper layers with depths of approximately 15 to 35 feet have corrected (NI)60 values less than 15 and depths below 35 feet have corrected (NI)60 values greater than 15. Therefore, the upper layers are considered to be susceptible to lateral spreading. However, based on the relatively flat topography of the Plan Area and its surroundings and the lack of significant nearby free faces, the potential for lateral spreading is considered low (Geotechnologies 2019).

Earthquake-Induced Landslides

The Plan Area is relatively flat with very minor elevation changes. The State of California Seismic Hazard Zones Map (Long Beach Quadrangle) indicates that the Plan Area is not within an Earthquake-Induced Landslide Zone (CGS 1999). Additionally, the County of Los Angeles Landslide Inventory Map and Seismic Safety Element of the City of Long Beach General Plan indicate that the Plan Area is not within an area susceptible to landslides. Therefore, the potential of landslides at the Plan Area is considered low.

Expansive Soils

Expansive soils shrink or swell as the moisture content decreases or increases; the shrinking or swelling can shift, crack, or break structures built on such soils. Results of the Geotechnical Investigation concluded that the composition of onsite materials is in the very low expansive range with an Expansion Index of 10 (Geotechnologies 2019).

Subsidence

Subsidence is a regional lowering of the ground surface. The major cause of ground subsidence is withdrawal of groundwater; withdrawal of oil and gas can also cause subsidence. Subsidence due to oil and gas withdrawal has occurred in the Long Beach Harbor area and along the coast extending eastward to the City of Seal Beach, amounting up to 30 feet in the center of the Long Beach Harbor. Water injection has been used to stabilize the area since 1958; soil has also been imported to help keep port land uses usable (Long Beach 2004).

Corrosive Soils

Corrosive soils can lead to deterioration of buried structures such as underground utilities. Results of the Geotechnical Investigation indicated that the near-surface soils are considered severely corrosive to ferrous metals (metals that contain mostly iron) and aggressive to aluminum (Geotechnologies 2019).

Collapsible Soils

Collapsible soils are low-density, silty to very fine-grained, predominantly granular soils, containing minute pores and voids. When saturated, these soils undergo a rearrangement of their grains and a loss of cementation, causing substantial, rapid settlement under even relatively low loads. A rise in the groundwater table or an increase in surface water infiltration, combined with the weight of a building or structure, can cause rapid settlement and consequent cracking of foundations and walls. The upper few feet to several feet of existing soils on a project site – whether native soils or soils on a developed site – are often unsuitable to support a building. Geotechnical investigation reports provide recommendations for site preparation, excavation, and grading, including replacement of existing soils with engineered fill soils capable of supporting a building.

Paleontological Resources

The Plan Area is in the Los Angeles Basin and part of the costal section of the northernmost Peninsular Range Geomorphic Province. The Peninsular Ranges Geomorphic Province is characterized by northwest-trending mountain ridges separated by sediment-floored valleys and bounded by the Transverse Ranges Geomorphic Province to the north and the Colorado Desert Geomorphic Province to the east. The geologic units underlying the Plan Area are mapped entirely as late Pleistocene to Holocene young alluvium (unit 2) which was deposited between 126,000 years ago and through into historic times. These deposits consists of poorly sorted, permeable clays to sands. Fossils of Monterey cypress, Monterey pine, and Torrey pine have been found in middle to late Pleistocene deposits (Cogstone 2020).

5.5.2 Thresholds of Significance

According to Appendix G of the CEQA Guidelines, a project would normally have a significant effect on the environment if the project would:

G-1 Directly or indirectly cause potential substantial 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 42.)
- ii) Strong seismic ground shaking.
- iii) Seismic-related ground failure, including liquefaction.
- iv) Landslides.

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

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

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

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

G-6 Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

The Initial Study, included as Appendix A, substantiates that impacts associated with the following thresholds would be less than significant:

- Threshold G-1i
- Threshold G-1iv
- Threshold G-2
- Threshold G-5

These impacts will not be addressed in the following analysis.

5.5.3 Environmental Impacts

5.5.3.1 IMPACT ANALYSIS

The following impact analysis addresses thresholds of significance for which the Initial Study (Appendix A) disclosed potentially significant impacts. The applicable thresholds are identified in brackets after the impact statement.

Impact 5.5-1: Future development in the Plan Area pursuant to the Specific Plan would expose increased numbers of persons and structures to strong ground shaking from active faults in the region. [Threshold G-1.ii]

Impact Analysis: The most significant geologic hazard to development accommodated by the Specific Plan is the potential for moderate to strong ground shaking resulting from earthquakes generated on the faults in seismically active southern California. As with other areas in southern California, it is anticipated that strong ground shaking can be expected to occur during the design lifetimes of structures that would be built pursuant to the Specific Plan. Specifically, buildout in accordance with the Specific Plan would result in a total of 1,380 dwelling units, 79,350 square feet of amenities, 15,000 square feet of educational uses, 22,850 square feet of commercial/retail uses, and 67,050 square feet of administrative and supportive services, accounting for the new development and the existing development which will remain in the Plan Area. The Specific Plan would attract 2,100 residents to the Plan Area, potentially exposing increased numbers of persons and structures to strong ground shaking.

As noted above, the Newport-Inglewood Fault is approximately 2.4 miles to the northeast (CGS 2020). This active fault, as well as others in the region (including the Palos Verdes Fault Zone, offshore about 7 miles to the south, and the Whittier Fault about 15 miles to the northeast) are considered capable of producing strong shaking at the Plan Area, thereby exposing people or structures onsite to potential substantial adverse effects, including the risk of loss, injury, or death. Earthquakes along active faults are generally capable of generating ground shaking of engineering significance to the Plan Area. The intensity of ground shaking on the Plan Area would depend on the magnitude of the earthquake, distance to the epicenter, and the geology of the area between the epicenter and the Plan Area.

However, the Plan Area is not at a greater risk of seismic activity or impacts than other sites in southern California. Seismic shaking is a risk throughout Southern California. Additionally, California and the City o regulate development in the City through a variety of tools that reduce geologic hazards, including earthquakes. For example, the state regulations protecting human-occupied structures from geoseismic hazards are provided in the most recent CBC and CRC. The CBC and CRC, both adopted by reference in the

City's municipal code, contain provisions to safeguard against major structural failures or loss of life caused by earthquakes or other geologic hazards. For example, the CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground motion with specified probability of occurring at the site. The design and construction of future development projects that would be accommodated by the Specific Plan would be required to adhere to the provisions of the CBC and CRC, which are imposed on project developments by the City's Development Services Department during the development review and building plan check process. Compliance with the requirements of the CBC and CRC for structural safety during a seismic event would reduce hazards from strong seismic ground shaking.

Furthermore, requirements for geotechnical investigations are included in CBC Appendix J (Grading), Section J104.3 (Geotechnical Reports). Future development projects accommodated by the Specific Plan would be required to have site-specific geotechnical investigation reports prepared by the project applicant's/developer's geotechnical consultant, in accordance with the CBC. The geotechnical investigations would determine seismic design parameters for the site and the proposed building type per CBC requirements. For example, testing of samples from subsurface investigations (such as from borings or test pits) would be undertaken as a part of the geotechnical report. The soil samples would be analyzed 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, expansiveness, and other characteristics and factors. Also, CBC Section 1705.6 establishes requirements for inspection and observation during and after grading. Compliance with the design parameters and recommendations of the geotechnical investigation reports and the provisions of the CBC would be required as a condition of a grading permit and/or building permit, and would be ensured by the City's Development Services Department during the development review and building plan check process.

In summary, compliance with the provisions of the CBC and required implementation of the recommended design recommendations outlined in the geotechnical reports—which as noted above, is required to be prepared pursuant to the CBC—would reduce hazards arising from strong seismic ground shaking. Therefore, impacts resulting from strong ground shaking would be less than significant.

Impact 5.5-2: Future development in the Plan Area pursuant to the Specific Plan would subject persons and structures to hazards from liquefaction. [Threshold G-1.iii]

Impact Analysis: Liquefaction occurs when three general conditions coexist: 1) shallow groundwater; 2) low density non-cohesive (granular) soils; and 3) high-intensity ground motion. According to the Geotechnical Investigation, the entire Plan Area is within a liquefaction zone and the subsurface conditions are considered to be susceptible to liquefaction (Geotechnologies 2019). Therefore, development within Plan Area pursuant to the Specific Plan could expose people and structures to seismic-related ground failure from liquefaction.

However, future development projects accommodated by the Specific Plan would be required to have site-specific geotechnical investigation reports prepared by the project applicant's/developer's geotechnical consultant, in accordance with Appendix J (Grading) Section J104.3 (Geotechnical Reports) of the CBC. Such investigation would assess liquefaction potential on individual development sites and provide any

needed recommendations to minimize hazards from liquefaction. For example, recommendations from the Geotechnical Investigation include implementation of ground improvement techniques for building construction, such as the installation of aggregate piers. Implementation of the recommendations during the design and construction phases of development projects accommodated by the Specific Plan would mitigate the potential for surface manifestations of liquefaction and a loss in bearing strength (Geotechnologies 2019). Compliance with CDC Appendix J, Section 104.3, the recommendations of the individual geotechnical investigation reports would be required as a condition of approval prior to grading permit and/or building permits and would be ensured by the City's Development Services Department during the development review and building plan check process. Therefore, impacts resulting from hazards due to liquefaction would be less than significant.

Impact 5.5-3: Future development in the Plan Area pursuant to the Specific Plan could subject persons or structures to hazards arising from off-site landslide, lateral spreading, subsidence, collapsible soils, or expansive soils. [Thresholds G-3 and 4]

Impact Analysis: The potential impacts resulting from development in the Plan Area pursuant to the Specific Plan are addressed below.

Landslides and Lateral Spreading

Slope failures in the form of landslides are common during strong seismic shaking in areas of steep hills. The Plan Area generally flat with no significant slopes. The State of California Seismic Hazard Zones Map (Long Beach Quadrangle), the County of Los Angeles Landslide Inventory Map and Seismic Safety Element of the City of Long Beach General Plan indicate that the Plan Area is not within an area susceptible to landslides. Additionally, landslides are not expected to occur at the Plan Area since the site and its surroundings are relatively flat. Therefore, no impacts related to landslides are anticipated.

Lateral spreading is a phenomenon that occurs in association with liquefaction and includes the movement of non-liquefied soil materials. As discussed in Section 5.1.1.2, results of the geotechnical report indicated that the potential for lateral spreading is considered low (Geotechnologies 2019). Therefore, impacts associated with lateral spreading would be less than significant.

Subsidence, Collapsible, Expansive, and Corrosive Soils

Subsidence and Collapsible Soils

The major cause of ground subsidence is the excessive withdrawal of groundwater. Soils with high silt or clay content are particularly susceptible to subsidence. Based on the conditions encountered in the borings conducted for the Geotechnical Investigation, groundwater was encountered at depths of 4.5 to 8 feet below existing grade, and historical high groundwater levels under the Plan Area is approximately 15 feet below ground surface (Geotechnologies 2019). Collapsible soils shrink upon being wetted and/or subjected to a load. As the soils consisting of existing fill and native soils are not considered suitable to support new structures accommodated by the Specific Plan, removal and recompaction of the upper 1 to 2 feet of soils prior to foundation excavation, placement of floor slabs, or additional fill was recommended in the

Geotechnical Investigation. Other recommendations included a number of grading guidelines, including but not limited to:

- Removal of all vegetation, existing fill, and soft or disturbed earth materials from areas to receive controlled fill.
- Compaction of loose soils and placement of controlled fill.
- Conduction of field observations and testing by a geotechnical engineer during grading to assist the construction contractor in addressing compaction and proper moisture content.

Additionally, future development projects accommodated by the Specific Plan would be required to have site-specific geotechnical investigation reports prepared by the project applicant's/developer's geotechnical consultant, in accordance with Appendix J (Grading) Section J104.3 (Geotechnical Reports) of the CBC. Such investigation would assess hazardous soil conditions onsite and would provide recommendations as needed to minimize these potential soils hazards. Further, CBC Section 1705.6 sets forth requirements for inspection and observation during and after grading. Compliance with the recommendations of the geotechnical reports and CBC is required as a condition of approval prior to a grading permit and/or building permit and would be ensured by the City's Development Services Department during the development review and building plan check process. Therefore, impacts resulting from collapsible soils and subsidence would be less than significant.

Corrosive Soils

Results of the Geotechnical Investigation indicated that the near-surface soils are considered severely corrosive to ferrous metals (metals that contain mostly iron) and aggressive to aluminum (Geotechnologies 2019). The corrosivity findings were based on a soil corrosivity study prepared by a geotechnical engineer and provided as an appendix to the Geotechnical Investigation. Corrosion control recommendations in the soil corrosivity study included but are not limited to:

Steel Pipe

- Install underground steel pipe with rubber gasketed, mechanical, grooved end, or other nonconductive type joints. Pipes should be bonded for electrical continuity, which is necessary for corrosion monitoring and cathodic protection.
- Installation of corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection.

Hydraulic Elevators

- Coat hydraulic elevator cylinders with a suitable dielectric coating intended for underground use.
- Electrically insulate each cylinder from building metals by installing dielectric material between the piston platen and car, insulating the bolts, and installing an insulated joint in the oil line.

Additionally, as noted above, future development projects accommodated by the Specific Plan would be required to have site-specific geotechnical investigation reports prepared by the project applicant's/developer's geotechnical consultant, in accordance with Appendix J (Grading) Section J104.3 (Geotechnical Reports) of the CBC and to comply with all applicable regulatory measures. CBC Section 1705.6 sets forth requirements for inspection and observation during and after grading. Compliance with the recommendations of the geotechnical reports and CBC is required as a condition of approval prior to a grading permit and/or building permit and would be ensured by the City's Development Services Department during the development review and building plan check process. Therefore, impacts resulting from corrosive soils would be less than significant.

Expansive Soils

Results of the Geotechnical Investigation indicated that onsite soils have a very low expansive potential (Geotechnologies 2019). Therefore, no impact associated with expansive soils would occur.

Impact 5.5-4: Build out of the Specific Plan could directly or indirectly destroy a unique paleontological resource or site or unique geologic feature [Threshold G-6]

Impact Analysis: The Cultural and Paleontological Resources Assessment Report included thorough background research and analysis, geologic map and literature reviews, and previous locality data searches, to evaluate the paleontological sensitivity of the Plan Area. Specifically, the Cultural and Paleontological Resources Assessment Report included a paleontological records search with the Natural History Museum of Los Angeles County (LACM) as well as a field survey of the Plan Area on December 18, 2019. The survey consisted of walking in parallel transects spaced at approximately 10-meter intervals while closely inspecting the ground surface. The type of sediment and land formations were also noted in order to assess the potential for paleontological sensitivity. Existing ground disturbances (e.g. cutbanks, ditches, animal burrows, etc.) were also visually inspected to get a sense of subsurface deposits and soil horizons.

No archaeological or paleontological resources were observed within the Plan Area during the field survey (Cogstone 2020). The record search conducted with LACM also found no recorded paleontological localities producing vertebrae fossils in or within one-mile of the Plan Area. However, seven localities from Pleistocene deposits between one to three miles and sixteen localities between three to ten miles from the Plan Area were found. These localities include mammoth, horse, tapir, pronghorn antelope, camel, and bison megafauna. All fossils were at least 5 feet deep in deposits and mapped as late Pleistocene at the surface while fossils starting at 24 feet deep were mapped as Holocene (Cogstone 2020).

In order to assess the sensitivity of sediments for fossils to occur in the Plan Area, the Potential Fossil Yield Classification (PFYC) system developed by the Bureau of Land Management (BLM) was used. The PFYC system uses the geological setting and number of known fossil localities to determine the paleontological sensitivity of site. Using the PFYC system, geologic units are classified according to the relative abundance of vertebrate fossils or scientifically significant invertebrate or plant fossils and their sensitivity to adverse impacts within the known extent of the geological unit. The PFYC system ranks paleontological sensitivity using a scale of 1 to 5 (1 being very low; 5 being very high).

The Plan Area is mapped entirely as middle to late Pleistocene older alluvium. The records search indicated that all previously recovered fossils were at least five feet deep and mapped as Pleistocene at the surface. Sediments with a Holocene component produced fossils starting at 24 feet deep. As shown in Table 5.5-1, sediments less than 20 feet below the surface are assigned a low potential for fossil (PFYC 2) due to the lack of fossils in these deposits while sediments more than 20 feet below surface are assigned a moderate potential for fossils (PFYC 3) due to similar deposits producing fossils at that depth near the Plan Area.

Table 5.5-1 Paleontological Sensitivity Rankings

	PFYC Rankings				
Rock Unit	5 Very High	4 High	3 Moderate	2 Low	1 Very Low
Older alluvium, middle to late Pleistocene			More than 20 feet deep	Less than 20 feet deep	

Sources: Cogstone 2020

Furthermore, based on fossils found in similar sediments nearby, no paleontological monitoring is currently recommended for the mass excavations of development projects accommodated by the Specific Plan. Also, drilling activities, regardless of depth, have a low potential to produce fossils meeting significance criteria because any fossils brought up by the auger during drilling will not have information about formation, depth, or context. The only instance in which such fossils will meet significance criteria is if the fossil is a species new to the region.

However, should excavation exceed a depth of 20 feet below surface, there is the potential to encounter paleontological resources. For example, recommendations from the Geotechnical Investigation include implementation of ground improvement techniques for building construction, such as the installation of aggregate piers. As stated in the Geotechnical Investigation, ground improvements should extend from the ground surface to a minimum depth of 30 feet. Therefore, grading activities at depths of 20 feet or greater have the potential to encounter unknown, buried resources, and impacts are considered potentially significant.

5.5.4 Cumulative Impacts

Geology and soils impacts are site-specific and generally do not combine to result in cumulative impacts. Similar to the Specific Plan, other development projects in the City would be required to comply with applicable state and local building regulations, including the CBC. Site-specific geologic hazards would be addressed in each project's geotechnical investigation. Additionally, other development projects in the City would be subject to the same resource protection requirements as the Specific Plan. Other development projects would also require site specific paleontological analysis that could lead to mitigation requiring monitoring and recovery, identification, and curation of any resources discovered. Therefore, no significant cumulative impact would occur and the Specific Plan's contribution would not be cumulatively considerable.

5.5.5 Level of Significance Before Mitigation

Upon implementation of regulatory requirements, the following impacts would be less than significant: 5.5-1, 5.5-2, and 5.5-3.

Without mitigation, these impacts would be **potentially significant**:

- **Impact 5.5-4** Grading activities have the potential to encounter buried paleontological resources at depths below 20 feet.

5.5.6 Mitigation Measures

Impact 5.5-4

GEO-1 Prior to the issuance of grading permits for excavations of 20 feet or greater, the project applicant for each development or redevelopment project accommodated by the Century Villages at Cabrillo Specific Plan shall retain a qualified paleontologist who meets the Secretary of the Interior's Professional Qualifications Standards to monitor all grading activities. If paleontological resources are encountered during the course of ground disturbance, the paleontological monitor shall have the authority to temporarily stop construction work within 50 feet of the find in order to assess its significance. Suspension of ground disturbances in the vicinity of the discovery shall not be lifted until the paleontologist has evaluated the discovery. Work may continue in other areas of the Plan Area and for other project elements while the encountered find is evaluated.

If upon examination the resource is determined to be a significant paleontological resource, the qualified paleontologist shall make recommendations on the treatment and disposition of the resource. The paleontologist shall prepare a Paleontological Resources Impact Mitigation Program (PRIMP) consistent with the guidelines of the Society of Vertebrate Paleontology. The PRIMP shall include the methods that will be used to protect identified paleontological resources, as well as procedures for monitoring, fossil preparation and identification, curation into a repository, and preparation of a report at the conclusion of grading. A copy of the final report shall be submitted to the City of Long Beach Development Services Department.

5.5.7 Level of Significance After Mitigation

With the implementation of Mitigation Measure GEO-1, potential impacts associated with paleontological resources would be less than significant. Therefore, no significant unavoidable adverse impacts relating to paleontological resources have been identified.

5.5.8 References

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