3.7 GEOLOGY AND SOILS

Geologic and soil-related concerns in Southern California are related to potential seismic hazards such as ground shaking, low to moderate liquefaction, landslides, expansive soils, and soil stability. The Los Angeles Zoo has older buildings that do not meet current building standards. In this case, these buildings may present a hazard to public safety during an earthquake. The Project would involve redevelopment of older buildings with new buildings that would meet the most current and stringent building safety requirements including Title 24, Part 2 of the California Building Code and the Los Angeles Building Code, thus reducing the level of risk within the Zoo compared to existing conditions. Further, phased development of the Project would require preparation of a site-specific Geotechnical Report in accordance with City of Los Angeles requirements and implement any necessary measures to reduce geologic/soil hazards. Additionally, Project construction would involve soil excavation and grading that would necessitate development standards and best management practices to ensure soil stability.

This section describes existing geologic and soil conditions and analyzes the potential for impacts related to geologic hazards that could result from implementation of the proposed Los Angeles Zoo (Zoo) Vision Plan (Project) in the City of Los Angeles (City). Potential issues of concern related to geology and soils include fault rupture, ground shaking, liquefaction, dynamic dry settlement, expansive soils, and landform/landslide. Additionally, this section describes and evaluates potential impacts to paleontological resources and unique geological features underlying the Project site that may be adversely affected during Project construction.

3.7.1 Environmental Setting

Regulatory Setting

Federal Regulations


By Congressional policy, this law provides permanently for the control and prevention of soil erosion by preventative measures, including but not limited to engineering operations, methods of cultivation, growing of vegetation, and changes in land use.

Clean Water Act Section 402 (National Pollutant Discharge Elimination System [NPDES] Program)

This act mandates that certain types of construction activity comply with the requirements of the U.S. EPA’s NPDES program. Under State Water Resources Control Board (SWRCB) enforcement, the Los Angeles Regional Water Quality Control Board (RWQCB) implements the NPDES program in the City. The program requires a General Construction Activities
Permit, including implementation of established Best Management Practices (BMPs) for management of storm water, erosion control, and/or siltation.

**International Building Code (IBC)**

The IBC, most recently updated in 2018, is published by the International Code Council (ICC) and forms the basis for building codes in the United States, including the California Building Code (established as Title 24 of the California Code of Regulations). The IBC has been adopted by the California Legislature with amendments 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 Regulations**

**Alquist-Priolo Earthquake Fault Zoning Act (1972)**

The purpose of the Alquist-Priolo Act is to regulate types of development near active faults to mitigate the hazard of surface rupture. Under this Act, the State Geologist is required to delineate earthquake fault zones, or Alquist-Priolo Fault Zones along known active faults in California and requires that geologic studies be conducted to locate and assess any active fault traces in and around known active fault areas prior to development of buildings for human occupancy. The Alquist-Priolo Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. Local cities and counties must regulate certain development projects within the Earthquake Fault Zones, generally by issuing building permits only after geologic investigations demonstrate that development sites are not threatened by future surface displacement. A buffer prohibiting the construction of structures for human occupancy may be established. Typically, structures for human occupancy are not allowed within 50 feet of the trace of an active fault. Projects subject to these regulations include all land divisions and most buildings intended for human occupancy.

**California Building Code (CBC) (2019)**

The State of California provides minimum standards for building design through the CBC, which is based on the IBC, but has been modified to account for California’s unique geologic conditions, including the State’s heightened seismicity risk. The CBC (Title 24 of the California Code of Regulations) is updated triennially, and the most recent 2019 code became fully effective on July 1, 2019. The CBC applies statewide and is selectively adopted by local jurisdictions based on local conditions. The City through the Los Angeles Municipal Code (LAMC) Chapter IX Article 1, Building Code, has adopted the CBC, 2016 Edition, which adopts by reference the IBC, 2015 Edition, as part of its building regulations.

Section 1803.5.3 of the CBC states that in areas likely to have expansive soil, the building official shall require soil tests to determine where such soils do exist. Soils meeting all four of the following provisions shall be considered expansive, except that tests to show compliance with Items 1, 2, and 3 shall not be required if the test prescribed in Item 4 is conducted:
1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D 4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 micrometers),
determined in accordance with ASTM D 422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size,
determined in accordance with ASTM D 422.
4. Expansion index greater than 20, determined in accordance with ASTM D 4829.

Seismic Hazards Mapping Act

To address the effects of strong ground shaking, liquefaction, landslides, and other ground
failures due to seismic events, the State of California passed the Seismic Hazards Mapping
Act of 1990. Under the Seismic Hazards Mapping Act, the State Geologist is required to
delineate “seismic hazard zones.” Cities and counties must regulate certain development
projects within these zones until the geologic and soil conditions of the Downtown District
are investigated and appropriate mitigation measures, if any, are incorporated into
development plans. The City is mapped as part of the Beverly Hills Quadrangle Seismic
Hazard Zone Map.

The State Mining and Geology Board provides additional regulations and policies to assist
municipalities in preparing the Safety Element of their General Plan and encourage land use
management policies and regulations to reduce and mitigate those hazards to protect public
health and safety. Under Public Resources Code (PRC) Section 2697, cities and counties shall
require, prior to the approval of a project located in a seismic hazard zone, a geotechnical
report defining and delineating any seismic hazard. Each city or county shall submit one copy
of each geotechnical report, including mitigation measures, to the State Geologist within 30
days of its approval.

Public Resources Code (PRC) Sections 5097.5 and 30244

Other state requirements for paleontological resources are included in PRC Section 5097.5
and PRC Section 30244. Section 5097.5 states that “a person shall not knowingly and willfully
evacuate upon, or remove, destroy, injure, or deface, any historic or prehistoric ruins, burial
grounds, archaeological or vertebrate paleontological site, including fossilized footprints,
inscriptions made by human agency, rock art, or any other archaeological, paleontological or
historical feature, situated on public lands, except with the express permission of the public
agency having jurisdiction over the lands.” Section 5097.5 also states that “a violation of this
section is a misdemeanor, punishable by a fine not exceeding ten thousand dollars ($10,000),
or by imprisonment in a county jail not to exceed one year, or by both that fine and
imprisonment.” This section defines public lands as “lands owned by, or under the
jurisdiction of, the state, or any city, county, district, authority, or public corporation, or any
agency thereof.”
Section 30244 states that “where development would adversely impact archaeological or paleontological resources as identified by the State Historic Preservation Officer, reasonable mitigation measures shall be required.”

**Society for Vertebrate Paleontology (SVP) Guidelines**

The SVP has established standard guidelines that outline professional qualifications, protocols, and practices for paleontological resources assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, specimen preparation, identification, analysis, and curation (SVP 2010). Most practicing professional vertebrate paleontologists adhere closely to the assessment, mitigation, and monitoring requirements as specifically provided in the SVP Guidelines. Most state regulatory agencies with paleontological resource-specific Laws, Ordinances, Regulations, and Standards (LORS) accept and use the professional standards set forth by the SVP.

**Local Regulations**

**Los Angeles General Plan Safety Element**

The City’s General Plan Safety Element (Safety Element), which was adopted in 1996, addresses public safety risks due to natural disasters, including seismic events and geologic conditions; and sets forth guidance for emergency response during such disasters. The Safety Element also provides generalized maps of designated areas within the City that are considered susceptible to earthquake-induced hazards such as fault rupture and liquefaction.

Regarding assessment of seismic hazards, the Safety Element acknowledges that PRC Section 2699 requires that a safety element consider available seismic hazard maps prepared by the State Geologist pursuant to the Alquist-Priolo Earthquake Fault Zoning Act to assess seismic hazards. The PRC also requires that the State Geologist map active faults throughout the state. The Safety Element states that those maps which are applicable to the City are incorporated into Exhibit A of the Safety Element. The Safety Element also states that local jurisdictions are required by the Seismic Hazards Mapping Act to require additional studies and appropriate mitigation measures for development projects in the areas identified as potential hazard areas by the state seismic hazard maps. In addition, the Safety Element states that as maps are released for the City, they will be utilized by the Los Angeles Department of Building and Safety (LADBS) to help identify areas where additional soils and geology studies are needed for evaluation of hazards and imposition of appropriate mitigation measures prior to the issuance of building permits.

The Safety Element acknowledges that it was based on available official maps at the time, and that exhibits in the Safety Element would be revised following receipt of reliable new information. The State of California released the current official and final Earthquake Zones of Required Investigation Map for the Burbank Quadrangle on March 25, 1999. This map is the State of California’s official earthquake fault zone map for the portion of the City that
3.7 Geology and Soils

includes the Project site. It is the most current and accurate map available to delineate the boundaries of earthquake fault zones and seismic hazard zones within this portion of the City.

**City of Los Angeles Building Code**

Earthwork activities, including grading, are governed by the Los Angeles Building Code, which is contained in LAMC Chapter IX, Article 1. Specifically,

- Section 91.7006.2 requires the submittal of soils and geological reports to LADBS for review and approval for all grading work in excess of 5,000 cubic yards (cy) of cut and fill;
- Section 91.7006.7 includes requirements regarding import and export of earth material;
- Section 91.7010 includes regulations pertaining to excavations;
- Section 91.7011 includes requirements for fill materials;
- Section 91.7014 includes general construction requirements, as well as requirements regarding flood and mudflow protection; and
- Section 91.7016 includes regulations for areas that are subject to slides and unstable soils.

In addition, Section 91.1803 includes specific requirements addressing seismic design, grading, foundation design, geologic investigations and reports, soil and rock testing, and groundwater. The Los Angeles Building Code incorporates by reference the CBC, with City amendments for additional requirements. LADBS is responsible for implementing the provisions of the Los Angeles Building Code.

**Existing Conditions**

**Regional Geologic Setting**

The Project site is in the northwestern portion of the Los Angeles Basin. The Los Angeles Basin is geologically divided into four structural blocks, which are generally bounded by prominent fault systems: the Northwestern Block, the Southwestern Block, the Central Block, and the Northeastern Block (Norris and Webb 1990). The Project site is located in the Northwestern Block, which is bounded on the south side by the Santa Monica and Raymond Hill faults, which is also the southern boundary of the east-west trending Transverse Ranges physiographic province (Norris and Webb 1990; Harden 1998).

Regional potential for faulting and seismicity in Southern California is largely affected by the San Andreas Fault Zone, which trends northwest/southeast from Baja California to the Oregon Coast. The San Andreas Fault Zone traverses the Antelope Valley area of California approximately 30 miles east of the City. The San Andreas Fault Zone separates two major tectonic plates comprising the earth's crust. West of the San Andreas Fault Zone lies the Pacific Plate, which moves in a northwesterly direction relative to the North American Plate. North of the Transverse Ranges Geologic Province, this fault trends more in an east-west
direction, known as “the Big Bend,” and causes the fault’s right-lateral strike-slip movement to produce north-south compression between the two plates. North-south compression in the San Andreas Fault Zone has been estimated from 5 to 20 millimeters (mm) per year. This oppositional movement of the two plates is a cause of fault ruptures (earthquakes) in western California.

Additionally, faults in the vicinity of the Project site that can produce strong ground motion include the Hollywood, Verdugo, Raymond, Sierra Madre, Elysian Park Blind Thrust, Puente Hills Blind Thrust, Santa Monica, and Newport-Inglewood (see Appendix J). The Santa Monica and Hollywood fault zones are part of a much longer system of oblique left-lateral/reverse faults that form the more than 150-mile-long southern boundary of the Transverse Ranges.

**Seismic Hazards**

**Faults, Seismicity, and Earthquakes**

Southern California is seismically active due to numerous faults which traverse the region. Faults are characterized by the California Geological Survey (CGS) as active, potentially active, or inactive, according to the last seismic activity of the fault. Active faults are faults that show evidence of surface displacement within the past 11,700 years (i.e., Holocene time). Potentially active faults are those that show evidence of fault rupture within the Quaternary geology time system between 11,700 and 2.6 million years ago (i.e., Pleistocene Age) (CGS 2010). Inactive faults are those without recognized activity within the past 2.6 million years. Buried thrust faults are faults without a surface expression but are a significant source of seismic activity. They are typically defined based on the analysis of seismic wave recordings of hundreds of small and large earthquakes in the Southern California area. Due to the buried nature of these blind thrust faults, their existence is usually not known until they produce an earthquake such as the Northridge Earthquake in 1994 which was produced by the Northridge blind thrust fault (also known as the Pico thrust fault).

The Project site is not located within a State of California Earthquake Fault Zone (formerly known as Alquist-Priolo Special Studies Zone). However, the site is in a seismically active area, as is the majority of southern California, and the potential for strong ground motion in the project area is considered significant during the design life of the proposed project. The numerous faults in southern California include active, potentially active, and inactive faults. As defined by the California Geological Survey (CGS), active faults are faults that have ruptured within Holocene time, or within approximately the last 11,000 years. Potentially active faults are those that show evidence of movement during Quaternary time (approximately the last 1.6 million years) but for which evidence of Holocene movement has not been established. Inactive faults have not ruptured in the last approximately 1.6 million years. The approximate locations of major faults in the site vicinity and their geographic relationship to the site are shown on Figure 3.7-1.
In addition to the mapped faults shown in Figure 3.7-1, the Elysian Park blind thrust fault is located approximately 7.6 miles from the site and the Puente Hills blind thrust fault is located approximately 8.5 miles east of the site (United States Geological Survey [USGS], 2008). Blind thrust faults are low-angle faults at depth that do not break the surface and are, therefore, not shown. Although blind thrust faults do not have a surface trace, they can be capable of generating damaging earthquakes and are included in Table 3.7-1, which lists selected principal known active faults within approximately 50 kilometers of the site that may affect the project and the maximum moment magnitude (Mmax) as published by the USGS (2008). The approximate fault-to-site distances were calculated using the USGS web-based program (2008).

Table 3.7-1. Active Faults within 30 Miles of the Project Site

<table>
<thead>
<tr>
<th>Fault</th>
<th>Distance (miles)</th>
<th>Maximum Moment Magnitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hollywood</td>
<td>2.0</td>
<td>6.7</td>
</tr>
<tr>
<td>Verdugo</td>
<td>2.3</td>
<td>6.9</td>
</tr>
<tr>
<td>Raymond</td>
<td>3.2</td>
<td>6.8</td>
</tr>
<tr>
<td>Sierra Madre</td>
<td>5.9</td>
<td>7.3</td>
</tr>
<tr>
<td>Elysian Park Blind Thrust</td>
<td>7.6</td>
<td>6.7</td>
</tr>
<tr>
<td>Puente Hills Blind Thrust</td>
<td>8.5</td>
<td>7.0</td>
</tr>
<tr>
<td>Santa Monica</td>
<td>8.5</td>
<td>6.6</td>
</tr>
<tr>
<td>Newport-Inglewood</td>
<td>9.4</td>
<td>7.5</td>
</tr>
<tr>
<td>San Gabriel</td>
<td>11.6</td>
<td>7.3</td>
</tr>
<tr>
<td>Northridge</td>
<td>10.5</td>
<td>6.9</td>
</tr>
<tr>
<td>San Andreas (1857 Rupture)</td>
<td>29.4</td>
<td>8.2</td>
</tr>
</tbody>
</table>

Source: USGS 2008. See Appendix J.

The Benedict Canyon fault is mapped along the north side of the mountains and has been projected to extend beneath the parking lot on the eastern side of the project area. The Hollister fault is mapped crossing the lower hillside areas and is projected to extend as a buried fault strand beneath the center of the Zoo. Neither the Benedict Canyon or Hollister faults are considered active and are not considered constraints to the Project.
Active Faults in the Vicinity of the Project Site
Fault Rupture

Fault rupture is the displacement and cracking of the ground surface along a fault trace. Fault ruptures are visible instances of horizontal or vertical displacement, or a combination of the two, typically confined to a narrow zone along the fault. Fault rupture is more likely to occur in conjunction with active fault segments where earthquakes are large, or where the location of the movement (earthquake hypocenter) is shallow.

The numerous faults in southern California include active, potentially active, and inactive faults. The criteria for these major groups are based on criteria developed by the CGS for the Alquist-Priolo Earthquake Fault Zone Program. An active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault has demonstrated surface displacement during Quaternary time (approximately the last 1.6 million years) but has had no known Holocene movement. Faults that have not moved in the last 1.6 million years are considered inactive.

The primary purpose of the Alquist-Priolo Earthquake Fault Zoning Program is to identify sites that have a potential for surface rupture due to active faults that are near the site. In such cases, a building setback zone is established to mitigate the potential for surface rupture. No major active faults are known to traverse the Project site. Accordingly, there are no Alquist-Priolo Earthquake Zones at the Project site. The nearest Alquist-Priolo Earthquake Zone to the Project site is the Hollywood fault, located approximately two miles south of the site (Table 3.7-1; Figure 3.7-1) (Appendix J). Thus, the potential for fault rupture appears to be moderate.

Tsunami Risk

Tsunamis are long wavelength, seismic, sea waves (long compared to ocean depth) generated by the sudden movements of the ocean floor during submarine earthquakes, landslides, or volcanic activity. Seiches are waves generated in large, enclosed bodies of water. Based on the elevation and location of Project the site away from large waterbodies, the risk for damage at the Project site due to tsunamis or seiches low.

Liquefaction

Liquefaction is a form of earthquake-induced ground failure that occurs primarily in relatively shallow, loose, granular, and water-saturated soils. Liquefaction occurs when ground shaking transforms granular material from a solid state to a liquefied state due to earthquakes, which can induce an increase in pore water pressures in the soils when subjected to strong earthquake-induced ground shaking. Unconsolidated silts, sands, and silty sands located below the water table are most susceptible to liquefaction. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below the ground surface. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking. Structures that are most
3.7 Geology and Soils

Vulnerable to liquefaction include buildings with shallow foundations, railways, buried structures, pipelines, retaining walls, utility poles, and towers.

Based on groundwater monitoring wells in the Project vicinity, the depth to groundwater in the vicinity of the site is estimated between 20 and 50 feet below the existing ground surface. The State of California Seismic Hazards Zones Map for the Los Angeles Quadrangle (1998), included in the Earthquake Zones of Required Investigation Map for the Burbank Quadrangle, has mapped the alluvium beneath the artificial fill in the lower elevations of Project site as being potentially susceptible to liquefaction during a strong earthquake event (Figure 3.7-2). Based on the nature of the underlying materials and the reported groundwater levels, the potential for dynamic settlement due to liquefaction is considered moderate in the lower lying areas of the Project site, including the main parking lot and center of the Zoo. The potential for liquefaction in the higher elevations of the site underlain by quartz diorite and sedimentary formational materials is low. Based on the site topography, the potential for lateral spread to occur at the Project site due to liquefaction is very low.

Dynamic Compaction

Relatively dry soils (e.g., soils above the groundwater table) with low density or softer consistency tend to undergo dynamic compaction during a seismic event. Earthquake shaking often induces significant cyclic shear strain in a soil mass, which responds to the vibration by undergoing volumetric changes. Volumetric changes in dry soils take place primarily through changes in the void ratio (usually contraction in loose or normally consolidated, soft soils and dilation in dense or over-consolidated, stiff soils) and secondarily through particle reorientation. Such volumetric changes are generally non-recoverable. Based on the nature of the underlying soil materials, the potential for dynamic compaction of dry soils is low to moderate.

Landslides

The stability of slopes and potential for landslides are affected by several factors, including gravity, rock and soil type, hydrologic conditions, and vegetation. Events that can cause a slope to fail include sudden movements, such as a seismic event, modification of the slope by natural or human activities, undercutting caused by erosion, and changes in hydrologic characteristics, including heavy rains that can saturate the soil.

There are no mapped landslides on site or in the vicinity, and the site is not mapped as having the potential for seismically induced landslides. In addition, review of stereoscopic aerial photographs does not indicate the presence of landslides on site or on the nearby hillside areas. Based on this information and the location of the site, large scale landslides are not considered to be a potential hazard at the site. However, offsite steep slopes along the western and northern portions of the Project site in the Asia, Africa, and California planning areas expose weathered quartz diorite materials and, in some areas, may be subject to small- to moderate-sized rock fall-type surficial slope failures.
Seismic Hazards in the Vicinity of the Project Site

FIGURE 3.7-2
Groundwater

The Project site overlies a portion of the San Fernando Valley Groundwater Basin (SFVGB). The SFVGB is the largest of the four basins in the upper Los Angeles River watershed, consisting of 112,000 acres and comprising 91.2 percent of the total basin area of this watershed. It is bounded on the east and northeast by the San Rafael Hills, Verdugo Mountains, and San Gabriel Mountains; on the north by the San Gabriel Mountains and the eroded south limb of the Little Tujunga Syncline which separates it from the Sylmar Basin; on the northwest and west by the Santa Susana Mountains and Simi Hills; and on the south by the Santa Monica Mountains. The delineated SFVGB boundary extends into the lower/flatter areas of the Zoo’s property. The portion of Zoo property overlapping the SFVGB is mostly developed and mostly consists of impervious surface cover, with a general groundwater gradient trending to the east, slightly southeast. Hillsides within the Zoo drain toward the lower/flatter areas of the Zoo. Based on groundwater monitoring wells in the Project vicinity, the depth to groundwater in the vicinity of the site is estimated between 20 and 50 feet below the existing ground surface of the lower elevation areas of the Project site (e.g., the central portion of the Zoo) (Appendix J).

Site Soil Setting

Regional geologic mapping data indicates that the lower elevations of the site, including the parking lot and the central portion of the Zoo, are underlain by younger alluvium consisting of moderately to poorly consolidated clay, sand, and gravel (Dibblee T.W. 1991) (Figure 3.7-2). The hills located on the northern and northwestern portions of the Zoo are composed of igneous quartz diorite bedrock. The quartz diorite is moderately to intensely weathered and composed of plagioclase feldspar, quartz, biotite, and hornblende. The hills along the southern edge of the site and south of the Zoo are composed of sedimentary sandstone and shale of the Topanga Formation.

The alluvium is overlain in the central portion of the Zoo by fill soils placed during the original construction of the Zoo in the mid-1960s and during later projects. Based on review of previous reports for individual projects within the Zoo, the fill soils range in thickness from less than 3 feet in the jaguar exhibit area (URS 2013), to 5 to 20 feet thick in the Gorilla Enclosure area (Kleinfelder 2000; 2004), and from 10 to deeper than 30 feet in the pachyderm enclosure area and in other areas of the central Zoo (City of Los Angeles, Geotechnical Engineering Group 2007; 2011; URS 2000). The fill is described as medium dense to dense siltly sand and sand and, although generally described as well compacted, some areas of loose and uncompacted fill are reported from these reports.

Soil Hazards

Erosion Susceptibility

Erosion of exposed soils and rocks occurs naturally due to physical weathering from water and wind action. The potential for erosion increases with steeper slopes, hydrologic events,
and exposed soils. Based on the use of the site and condition of the existing exposed soils, the susceptibility of soils to erosion is considered low to moderate.

**Expansive Soils**

Expansive soils are soils that can undergo a significant increase in volume with an increase in water content and a significant decrease in volume with a decrease in water content. Changes in the water content of an expansive soil can result in severe distress to structures constructed upon the soil. Expansive soils tend to swell with seasonal increases in soil moisture in the winter months and shrink as soils become drier in the summer months. Repeated shrinking and swelling of the soil can lead to stress and damage of structures, foundations, fill slopes, retaining walls, and other associated facilities.

Section 1803.2 of the 1994 Uniform Building Code (UBC) directs expansive soil tendency be categorized by Expansion Index (EI). The UBC mandates that “special [foundation] design consideration” be employed if the Expansion Index is 20, or greater, as recorded in UBC Table 18-1-B. Based on review of geotechnical previous reports for projects within the Zoo, the soils onsite are generally low to very low in expansion.

**Subsidence**

Subsidence is the downward shift of the ground surface and is most frequently caused by subsurface withdrawal of water (i.e., groundwater drawdown), oil, or natural gas earth extraction (e.g., subsurface mining), faulting, or seasonal changes in soil moisture content. Compaction of soils in some aquifer systems can accompany excessive groundwater pumping and is the largest cause of subsidence. This can result in a permanent reduction in the total storage capacity of the aquifer system in addition to the subsidence evident in the ground surface.

No evidence or records of historic wells at the Project site was encountered during site investigations and record searches. As a result, there appears to be little or no potential for ground subsidence due to withdrawal of fluids or gases at the Project site.

**Differential Settlement**

Differential settlement is the process whereby soils settle non-uniformly, potentially resulting in stress and damage to utility pipelines, building foundations, or other overlying structures. While strong ground-shaking often greatly exacerbates soil conditions already prone to differential settlement, such movement can also occur in the absence of seismically induced ground failure. Differential settlement occurs due to improper grading and soil compaction, or discontinuity of underlying fill and naturally occurring soils. Differential settlement results in distress and displacement for overlying structures. Elongated structures, such as pipelines or railways, are especially susceptible to damage as a result of differential settlement.

While risk for differential settlement is low in the vicinity of the Zoo, individual projects may encounter increased expansion potential related to soil compaction levels based on site-
specific soil conditions and testing results. In particular, the Zoo may be susceptible to differential settlement where uncompacted fills exist below a development site.

**Methane Zones**

The *Los Angeles Methane Zone Map* is a publication by the Los Angeles Department of Building and Safety (LADBS). This map identifies areas of hazardous subsurface methane gas within City limits. Hazardous gas zones are usually a result of naturally surfacing tar and crude oil, or shallow soil contamination by old oil drilling wells. Additionally, landfill sites are known to produce methane soil gas. The *Los Angeles Methane Zone Map* categorizes two types of zones; methane buffer zones and methane zones, based on proximity to a methane soil gas source. The Zoo is not located within a City Methane Zone or Methane Buffer Zone.

**Paleontological Resources**

Paleontological resources are the evidence of once-living organisms as preserved in the rock record. They include both the fossilized remains of ancient plants and animals and the traces thereof (e.g., trackways, imprints, burrows, etc.). In general, fossils are older than recorded human history or greater than 5,000 years old and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks under certain conditions (Appendix J).

Paleontological resources are the evidence of once-living organisms as preserved in the rock record. They include both the fossilized remains of ancient plants and animals and the traces thereof (e.g., trackways, imprints, burrows, etc.). In general, fossils are older than recorded human history or greater than 5,000 years old and are typically preserved in sedimentary rocks. Although rare, fossils can also be preserved in volcanic rocks and low-grade metamorphic rocks under certain conditions (Appendix J).

The geologic setting is key to understanding the potential for important paleontological resources to be located at the Project site. As stated above, the hills located on the northern and northwestern portions of the Zoo are composed of quartz diorite bedrock (qd) emplaced during the Late Mesozoic (Cretaceous Period). The low-lying, level portions of the Zoo are blanketed by alluvial material (Qa) deposited during the Quaternary either as alluvial fan deposits from the surrounding more elevated terrain or as fluvial deposits of gravels and sands from the Los Angeles River that currently flows in a concrete channel immediately to the east of the project site. The hills along the southern edge of the site and south of the Zoo are composed of marine sandstone and shale of the Upper Topanga Formation (Ttucg) deposited during the Middle Miocene.
Table 3.7-2. Geologic Units and Paleontological Sensitivity with Project Area

<table>
<thead>
<tr>
<th>Geologic Unit Symbol</th>
<th>Geologic Unit Name</th>
<th>Age</th>
<th>Paleontological Sensitivity</th>
<th>Location (Phase Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qa</td>
<td>Alluvium</td>
<td>Quaternary</td>
<td>Low (At or Near Surface) Moderate (At Depth)</td>
<td>1, 2, 3, 4, 5, 7</td>
</tr>
<tr>
<td>Ttucg</td>
<td>Upper Topanga Formation – Cahuenga Conglomerate Member</td>
<td>Middle Miocene</td>
<td>Moderate</td>
<td>3</td>
</tr>
<tr>
<td>qd</td>
<td>quartz diorite</td>
<td>Late Mesozoic (Cretaceous)</td>
<td>Low</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

Source: Dibblee, T.W. and H.E. Ehrenspeck 1991; See Appendix J.

Paleontological resources are found within the geologic deposits or bedrock that underlie the soil layer. A record search was conducted at the Los Angeles County Natural History Museum (LACM) to identify any paleontological localities within or near the Project site and to determine if paleontological resources have been recovered from geologic formation similar to those present, and likely to be impacted, at the Project site. LACM records include four paleontological localities within five miles of the Zoo. Of these four localities, two were recovered from older Quaternary alluvium deposits and two from the middle Miocene Upper Topanga Formation:

- The first Quaternary locality, LACM 6970, was discovered during excavations for the Metrorail Redline Universal City subway tunnel approximately 4.5 miles west of the Zoo at 60 to 80 feet below ground surface. This locality produced fossil specimens of camel (*Camelops hesternus*), bison (*Bison antiquus*), and ground sloth (*Glossotherium harlani*).
- The second Quaternary locality, LACM 342, was originally discovered circa 1940 at a depth of 14 feet below grade. This locality produced fossil specimens of turkey (*Parapavo californicus*) and mammoth (*Mammuthus* sp.).
- The first Miocene locality, LACM 6969, was discovered during excavations for the Metrorail Universal City subway station 4.3 miles west of the Zoo. Fossils specimens recovered from this locality include a diverse array of marine fish fossils, including grunion (*Antherinidae*), herring (*Etringus, Ganolytes, and Sardinella*), codlets (*Bregmacerotidae*), croakers (*Sciaenidae*), mackerel (*Scombridae*), and boarfish (*Caproidae*).
- The second Miocene locality, LACM 1084, was discovered near the intersection of Bonnie Hill Drive and Ione Place 4 miles west southwest of the Zoo. Fossil specimens recovered from this locality include material from Paleoparadoxia sp., an odd heavy-bodied, short-legged, marine mammal whose remains are rare in southern California.
3.7 Geology and Soils

3.7.2 Impact Assessment Methodology

Significance Thresholds

According to Appendix G of the CEQA Guidelines and the City of Los Angeles CEQA Thresholds Guide, a project would have a significant impact related to geology and soils if it would:

a. 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,

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 an onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse;

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

e. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems in areas where sewers are not available for the disposal of wastewater.

Additionally, the Appendix G of the CEQA Guidelines and the 2006 L.A. CEQA Thresholds Guide state that a project would have a significant impact related to paleontological resources if it would:

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

Non-applicable threshold(s):

- Threshold (e) (Soil capability of supporting wastewater disposal systems): The proposed Vision Plan does not propose the construction or use of a septic tank or alternative wastewater disposal system. All sewage generated onsite would be conveyed to the City’s North Outfall Sewer from a system of sewer lines beneath the Zoo (see Section 3.16, Utilities). Therefore, the proposed Project would not result in a significant impact due to soils incapable of adequately supporting the use of septic
tanks or alternative wastewater disposal systems, and this issue will not be analyzed further in this EIR.

**Methodology**

**Geology and Soils**

The proposed Project is primarily evaluated for geological risk including but not limited to seismicity, soil stability, and paleontology resources based on the site-specific geotechnical engineering investigation conducted for the Project site in 2019. Sources of regional and local information include, but are not limited to, the State of California’s Earthquake Zones of Required Investigation for the Burbank Quadrangle; the Safety Element of the City of Los Angeles General Plan; the City of Los Angeles GIS Application; and the California Department of Conservation.

To evaluate potential hazards relative to geology and soils, a *Draft Geotechnical Report* (2019) was prepared by Ninyo & Moore for the Project. The *Draft Geotechnical Report* included field exploration (i.e., geologic reconnaissance of the site and surrounding areas) and review of background information, including readily available geotechnical reports, geologic maps, fault maps, landslide maps, flood inundation maps, and aerial photographs to determine the characteristics of the subsurface conditions at the Project site. The Geotechnical Report is contained in Appendix J.

**Paleontological Resources**

Paleontological resources cannot be replaced once they are destroyed. Therefore, paleontological resources are considered non-renewable scientific resources and are protected under CEQA. Specifically, in Section VII(f) of Appendix G of the CEQA Guidelines, the “Environmental Checklist Form,” the question is posed: “Will the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?” In order to determine the uniqueness of a given paleontological resource, it must first be identified or recovered (i.e., salvaged). Therefore, mitigation of adverse impacts to paleontological resources is mandated by CEQA.

PRC Section 5097.5 affirms that no person shall willingly or knowingly excavate, remove, or otherwise destroy a vertebrate paleontological site or paleontological feature without the express permission of the overseeing public land agency. Under PRC Section 30244, any development that would adversely impact paleontological resources shall require reasonable mitigation. These regulations apply to projects located on land owned by or under the jurisdiction of the state or any city, county, district, or other public agency.

To assess potential impacts of the Project on paleontological resources, the SVP (2010) guidelines were used for the assessment of potential for paleontological resources to occur within the Project site. According to CEQA, the threshold of significance for impacts to paleontological resources is reached when a project would disturb or destroy scientifically
important fossil remains, as defined by the SVP. Significant paleontological resources are defined as “identifiable” vertebrate fossils, uncommon invertebrate, plant, and trace fossils that provide taphonomic (i.e., the study of what happens to an organism after its death and until its discovery as a fossil), taxonomic, phylogenetic, paleoecologic, stratigraphic, or biochronological data. These data are important because they are used to examine evolutionary relationships, provide insight on the development of and interaction between biological communities, establish time scales for geologic studies, and for many other scientific purposes (Scott and Springer 2003; SVP 2010). A literature review was conducted on museum collections records maintained by the UCMP, USGS published geologic mapping of the Burbank Quadrangle, and the Draft Geotechnical Report completed for the Project (Appendix J).

### 3.7.3 Environmental Impact Analysis

**GEO-1:** Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earth fault or strong seismic ground shaking?

The Zoo is located within the seismically active region of Southern California. Based on the most recently available studies and past fault mapping, no known faults traverse the Project site. Therefore, it is not mapped within an Alquist-Priolo Fault Zone. The closest fault is the Hollywood Fault, located 2 miles south of the Project site (see Figure 3.7-1).

As with all land in the region, the Project site would potentially be exposed to moderate to strong seismic ground shaking in the event of an earthquake on a nearby fault (e.g., Hollywood Fault, Verdugo Fault, Raymond Fault). A strong earthquake could result in substantial damage to older existing structures and infrastructure, including damage to foundations, shifting of frame structures, and breaking of underground pipes, windows and utilities if required building design measures are not implemented. This type of damage would put visitors and employees in danger from ground shaking and structural damage/collapse. At a given time, there would potentially be between 5,000 and 10,000 people within the Zoo that may be affected during a seismic event under the Project.

However, all new structures constructed at the Zoo would be required to adhere to the most current building standards of the LAMC and Los Angeles Building Code, which adopts CBC standards by reference with local amendments. Adherence to the LAMC and Los Angeles Building Code requirements would ensure the maximum practicable protection available for all structures. Specifically, Section 1613 of the 2016 CBC (Earthquake Loads) requires the seismic-resistant design for the project buildings to factor in a design earthquake that would create average peak ground accelerations of at least 1.0 g. Project design is required to include the application of Los Angeles Building Code seismic standards as the minimum seismic-resistant criteria. Adherence to the seismic design and construction parameters of the Los
Angeles Building Code would ensure the maximum protection feasible of structures and occupants during an earthquake.

In addition, the City is required to prepare and submit a site-specific geotechnical report for review and approval by the LADBS prior to the issuance of a grading or a building permit. Geotechnical reports would be prepared in accordance with the requirements of the County’s Manual for Preparation of Geotechnical Reports, which requires projects to evaluate site-specific geologic hazards, including ground shaking hazards. Projects are required to assess the site-specific peak ground acceleration associated with a 10 percent probability of exceedance in 50 years and are required to incorporate seismic design factors to mitigate for such risk. The LADBS requires the approval of a geotechnical report that specifically addresses site and building design at the time of final building plan check. The geotechnical report would be required to identify design requirements for structures and foundations to maintain structural integrity during an earthquake to the maximum extent feasible. All recommendations and design features in the geotechnical report are required to be incorporated into a Project component’s building design.

Further, the Zoo currently includes older buildings that do not meet current Los Angeles Building Code and CBC building standards. Many of these buildings may present a hazard to public safety during an earthquake. Redevelopment of existing outdated facilities under the proposed Vision Plan would facilitate the construction of new buildings that meet the most current and stringent seismic requirements, thus reducing the level of risk within each planning area and at the Zoo as a whole, compared to existing conditions. Therefore, compliance with the LABC, CBC, and adherence to the design recommendations detailed in site-specific geotechnical studies would reduce impacts related to seismic ground shaking to less than significant.

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

In the event of an earthquake on a nearby fault, seismic ground shaking has the potential to cause seismic-related ground failure such as liquefaction, differential settlement, or subsidence. If inadequately constructed without proper engineering design, buildings can experience damage from strong ground shaking during seismic events.

The potential for liquefaction hazards is greatest in areas with shallow, loose, granular, and water-saturated soils where depth to groundwater is 40 feet or less. The geologic hazards, including liquefaction hazards, posed at any given development site within the Project site are dependent upon the type of foundation, the structural design of the building, and the as-graded compaction and stability of the soil on which a structure was built.

Seismic settlement would develop if liquefaction or subsidence of the underlying saturated subsurface soils were to occur during a seismic event. As previously discussed, while the risk
for differential settlement is low to moderate at the Project site, individual projects may encounter increased expansion potential related to soil compaction levels based on site-specific soil conditions and testing results. In particular, the Zoo may be susceptible to differential settlement where uncertified fills exist below a development site.

The Zoo currently includes older buildings that do not meet current Los Angeles Building Code and CBC building standards. Many of these buildings may present a hazard to public safety during an earthquake. Redevelopment of existing outdated facilities under the proposed Vision Plan would involve the construction of new multi-story buildings (e.g., the California and Africa Visitor Centers), some with subterranean structures (e.g., Treetops Visitor Center kitchen). As discussed in GEO-1, all new structures constructed in the Zoo would be required to adhere to the most current building standards of the LAMC and Los Angeles Building Code, which adopts CBC standards by reference with local amendments. Adherence to the LAMC and Los Angeles Building Code requirements would ensure the maximum practicable protection available for all structures constructed within the Project site. Specifically, Section 1613 of the 2016 CBC (Earthquake Loads) requires the seismic-resistant design for buildings to factor in a design earthquake that would create average peak ground accelerations of at least 1.0 g. Project design is required to include the application of Los Angeles Building Code seismic standards as the minimum seismic-resistant criteria. Adherence to the seismic design and construction parameters of the Los Angeles Building Code would ensure the maximum protection feasible of the Zoo animal residents, employees, and visitors. Compliance with the CBC includes procedures to ensure the protection of structures and occupants from seismic hazards during an earthquake.

In addition, the Zoo is required to prepare and submit a site-specific geotechnical report for review and approval by the LADBS prior to the issuance of a grading or a building permit. Geotechnical reports would be prepared in accordance with the requirements of the County’s Manual for Preparation of Geotechnical Reports and are required to evaluate site-specific geological hazards, including potential ground failure from liquefaction, and identify seismic design factors to mitigate for such risk. The LADBS requires the approval of a geotechnical report that specifically addresses site and building design at the time of final building plan check. The geotechnical report would be required to identify design requirements for structures and foundations to maintain structural integrity during an earthquake to the maximum extent feasible. All recommendations and design features in the geotechnical report are required to be incorporated into a Project component’s building design.

Redevelopment of existing outdated facilities under the proposed Vision Plan would facilitate the construction of new buildings that meet the most current and stringent seismic requirements, thus reducing the level of risk on in each planning area and within the Zoo as a whole, compared to existing conditions. Therefore, compliance with the Los Angeles Building Code, CBC, and adherence to the design recommendations detailed in site-specific geotechnical studies would address potential impacts related to seismic-related ground failure, including liquefaction. With MM GEO-1 to ensure geotechnical investigations are
completed for each phase of Project development and that engineering techniques and technologies are integrated into final Zoo development plans, impacts related to ground failure would be *less than significant with mitigation*.

**GEO-3:** Would the project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides?

According to the Earthquake Zones of Required Investigation Map for the Burbank Quadrangle, the areas of landslide concern within the Project site include the Zoo Entry and undeveloped hillside proposed for the California planning area. The northwestern portion of the Zoo underlying the existing Papiano Play Park is also designated as an earthquake-induced liquefaction zone. The 2019 geotechnical investigation prepared for the Project concluded that the Project site is not located in an area considered susceptible to large-scale landslides (Appendix J). However, some slopes along the western and northern portions of the site were observed to expose weathered and fractured bedrock and may be subject to small to moderate sized rock falls.

Under the proposed Project, improvements within the California and Africa planning areas would be developed on sites within and adjacent to these exposed rock slopes. Several Project components would involve excavation and building construction techniques that would produce vibrations (such as jackhammering, drilling, blasting, and pile installation). The following Project components would involve excavation activities:

- Condor Canyon in the California planning area could include excavation up to 60 feet below ground surface.
- Aerial tram footings and/or foundations could extend up to 30 feet below the existing ground surfaces, cover approximately 100 square feet (sf) to 200 sf, and may require deep foundations (pile driving or pier drilling). The aerial tram alignment could result in this type and scale of ground disturbance at the Zoo Entry, California, World Aviary, Asia, and Africa planning areas.
- The California Visitor Center, Treetops Visitor Center, and Africa Visitor Center may include foundations extending 20 feet to 30 feet bgs. Treetops Visitor Center would include a subterranean level to support a restaurant and service facilities. Given existing topography, the California Visitor Center may result in hillside cuts with footings that may need deep foundations (pile driving or pier drilling).
- Five underground stormwater cisterns proposed for the Zoo Entry, Asia, Rainforest, and Africa would require excavation up to 20 feet bgs. Installation of stormwater pipes and infrastructure at depths of approximately 4 feet to 10 feet below ground surfaces could occur throughout these planning areas, and the overflow line would disturb soils beneath the existing southern surface parking lot to connect to the Zoo’s existing wastewater treatment plant.

- Proposed transportation improvements in Phase 1 would include improvements to Zoo Drive and Western Heritage Way, which may result in excavation of up to...
approximately 30 feet bgs to lower the road grade and install a bridge/overpass. The proposed 2,000-space parking structure in the northern surface parking lot is envisioned to have all above ground levels; however, in case a subterranean garage is contemplated, this review assumes the garage may require excavation up to 30 feet bgs.

Per MM GEO-1, these slopes would be observed, mapped, and further evaluated for Project components proposed adjacent to exposed rock slopes or if cuts slopes are planned in bedrock areas (e.g., California planning area). Therefore, impacts related to landslide risks would be less than significant with mitigation.

GEO-4: Would the project result in substantial soil erosion or the loss of topsoil?

Project construction presents the potential for erosion, particularly within the existing undeveloped areas of the Zoo. Construction of the California planning area, particularly Condor Canyon, as well as the Africa planning area hillsides, and Treetops Visitor Center subterranean kitchen would involve excavation activities that would disturb and loosen soils. The proposed aerial tram construction would also require excavation for installation of the pole foundations. In cases where construction activities would expose, excavate, or stockpile soils, erosion could occur during rain events. Approximately 22 acres of undeveloped areas with native topsoils would be developed under the Project, including 20 acres of topsoils in undeveloped areas in the California and Africa planning areas that would be graded and developed with pavement, structures, and landscaping.

The federal Clean Water Act requires that a NPDES storm water permit be obtained for all construction activities 1 acre or larger. In the State of California, the SWRCB administers the NPDES permit process. Acquisition of an NPDES permit is dependent on the preparation of a Storm Water Pollution Prevention Plan that contains specific actions, termed BMPs, to control the discharge of pollutants, including sediment, into the local surface water drainages.

All Project components would also be required to comply with the Stormwater and Urban Runoff Pollution Control Ordinance (Chapter VI Article 4.4 of the LAMC) to address soil erosion, including topsoil mobilization and loss, and urban runoff. Under this ordinance, construction projects in the City must follow additional specific BMPs. These BMPs must be put into practice at the time of demolition of an existing structure, or at the start of new construction, and must remain in place until a certificate of occupancy has been issued. With adherence to existing state and local regulations that address soil erosion, impacts potentially resulting from erosion or loss of topsoil would be less than significant.

GEO-5: Would the project be located on a geologic unit or soil that is unstable or that would become unstable as a result of the project and potentially result in an onsite or offsite landslide, lateral spreading, subsidence, liquefaction, or collapse?

During construction phases, excavation for California’s Condor Canyon, Treetop Terrace’s subterranean kitchen, the Africa hillside, and the aerial tram foundations may loosen exposed
soils or slopes. Exposed soil can cause instability within the excavation site or compromised stability for adjacent properties. As such, adequate sloping or shoring of soils would be necessary to provide structural support for neighboring buildings to prevent soil collapse during excavation. Shoring involves providing supports to hold the soil back, thereby providing sufficient support to maintain soil strength.

All excavation activities in the Project site would be required to adhere to mandatory regulations set forth by the California Occupational Safety and Hazard Administration (CalOSHSA) to ensure the safety of construction workers during excavation. These regulations include all requirements of Section 1541 (General Requirements) of Title 8 of the California Code of Regulations. Excavation activities would also be required to adhere with all provisions of the Los Angeles Building Code and CBC, including Section 3304 of Chapter 33 of the CBC, which includes requirements for safeguards at work sites to ensure stable excavations and cut or fill slopes. Excavation and shoring requirements are enforced through the City’s plan check process, which requires that project applicants prepare and submit excavation and shoring plans to the LADBS prior to the issuance of a building permit.

In addition, the City is required to prepare and submit a site-specific geotechnical report for review and approval by the LADBS prior to the issuance of a grading or a building permit. Geotechnical reports would be prepared in accordance with the County’s Manual for Preparation of Geotechnical Reports, which requires projects to evaluate site-specific geotechnical hazards and soil stability including soil creep, surficial stability, hydrocollapse/heave, compacted soils/fill, and shoring/excavation. The LADBS requires the approval of a geotechnical report that specifically addresses site and building design at the time of final building plan check. With MM GEO-1, these required geotechnical investigations would be completed for each phase of Project development and engineering techniques and technologies are integrated into final Zoo development plans. The geotechnical report would be required to identify building design requirements to ensure soil stability to the maximum extent feasible. All recommendations and design features in the geotechnical report are required to be incorporated into a Project component’s building design.

Further, the Zoo currently includes older buildings that do not meet current Los Angeles Building Code and CBC building standards. Many of these buildings may present a hazard to public safety during an earthquake. Redevelopment of outdated facilities under the proposed Vision Plan would facilitate the construction of new buildings that meet the most current and stringent building safety requirements, thus reducing the level of risk on a site and within the Zoo as a whole, compared to existing conditions. Therefore, compliance with the SM Los Angeles Building Code BC, CBC, and adherence to the design recommendations detailed in site-specific geotechnical studies would address potential impacts related to unstable soils.

Based on groundwater monitoring wells in the Project vicinity, the depth to groundwater in the vicinity of the site is estimated between 20 and 50 feet below the existing ground surface.
of the lower elevation areas of the Project site (e.g., the central portion of the Zoo). Redevelopment of outdated facilities under the proposed Vision Plan could involve the construction of subterranean structures up to 30 feet bgs. Groundwater dewatering may be necessary for the construction of subterranean structures in areas with a high groundwater table such as construction of the Treetops Terrace subterranean kitchen, where the 2019 geotechnical investigation indicated depth to groundwater ranging from 20 to 50 feet below grade. Additionally, in cases where the there is a high or perched groundwater table where the floor of subterranean structure encounters the groundwater table, ongoing groundwater dewatering may be necessary to prevent the percolation or inflow of groundwater into excavation pits and future basement levels. If the dewatering of groundwater is necessary, a dewatering permit from the RWQCB would be obtained (see Section 3.10, *Hydrology and Water Quality*).

As previously discussed, the City is required to prepare and submit a site-specific geotechnical report for review and approval by the LADBS prior to the issuance of a grading or a building permit. Geotechnical reports would be prepared in accordance with the requirements of the County’s Manual for Preparation of Geotechnical Reports and are required to evaluate site-specific geological hazards, including groundwater hazards. The LADBS requires the approval of a geotechnical report that specifically addresses site and building design at the time of final building plan check. The geotechnical report would be required to identify known historic groundwater levels onsite and identify measures to address groundwater impacts such as dewatering during construction as needed to protect against water contact and to minimize the seeping of water into the subterranean structure. All recommendations and design features in the geotechnical report are required to be incorporated into a Project component’s building design. Therefore, with **MM GEO-1** to ensure geotechnical investigations are completed for each phase of Project development and that engineering techniques and technologies are integrated into final Zoo development plans, geologic risks associated with unstable geology would be minimized and impacts would be *less than significant with mitigation*.

**GEO-6:** Would the project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?

The mapped surface geology of the Zoo includes three geological units as described above quartz diorite (qd), Quaternary alluvium (Qa), and Topanga Formation (Ttucg). Of these three units, two are sedimentary units, Qa, and Ttucg, with Moderate to High potential to contain significant paleontological resources. While the surficial components of the Quaternary-aged alluvial deposits may be generally too young or disturbed by previous surface disturbance to contain significant paleontological resources, fossil resources including a partial mammoth skeleton have been recovered during deeper excavations, greater than 10 feet bgs, of these units within five miles of the Zoo. Topanga Formation sediments located in the southwest portion of the Zoo, specifically within the Africa planning
area as the potential to contain significant paleontological resources at whatever depth it is encountered, including the surface.

Under the proposed Project, phased development would involve excavation and building construction techniques that would potentially impact paleontological resources depending upon their location and depth of excavation. The following Project components would involve excavation activities:

- Condor Canyon in the California planning area could include excavation up to 60 feet bgs in areas mapped as Qa and qd.
- Aerial tram footings and/or foundations could extend up to 30 feet below the existing ground surfaces, cover approximately 100 square feet (sf) to 200 sf, and may require deep foundations (pile driving or pier drilling). The aerial tram alignment could result in this type and scale of ground disturbance at the Zoo Entry, California, World Aviary, Asia, and Africa planning areas in areas mapped as Qa and qd.
- The California Visitor Center, Treetops Visitor Center, and Africa Visitor Center may include foundations and/or hillside cuts extending 20 feet to 30 feet bgs all within areas mapped as Qa. Treetops Visitor Center would include a subterranean level to support a restaurant and service facilities.
- Five underground stormwater cisterns proposed for the Zoo Entry, Asia, Rainforest, and Africa would require excavation up to 20 feet bgs. Installation of stormwater pipes and infrastructure at depths of approximately 4 feet to 10 feet below ground surfaces could occur throughout these planning areas, and the overflow line would disturb soils beneath the existing southern surface parking lot to connect to the Zoo’s existing wastewater treatment plant.
- Proposed transportation improvements in Phase 1 would include improvements to Zoo Drive and Western Heritage Way, which may result in excavation of up to approximately 30 feet bgs in areas mapped a Qa. Additionally, the proposed 2,000-space parking structure, in an area mapped as Qa, is envisioned to have all above ground levels; however, in case a subterranean garage is contemplated, this review assumes the garage may require excavation up to 30 feet bgs to account for potential subterranean levels.

Adverse environmental impacts on paleontological resources would potentially result from ground disturbing activities that would impact any part of the Upper Topanga Formation or Quaternary-aged alluvial deposits at 10 feet or greater bgs. These impacts would result from the potential destruction of fossil specimens by construction equipment or activities necessary to implement the Vision Plan. These adverse impacts would be considered significant if not mitigated through the implementation of recommended measures below. Mitigation measures would generally include monitoring of ground disturbing activities for discovery of fossil specimens as well as subsequent collection, preparation, and permanent deposition in a designated repository of fossil specimens. These actions would preserve paleontological resources that would otherwise be permanently lost.
Operation of the Zoo, following completion, of ground disturbing activities associated with all phases of the Vision Plan would not require additional ground disturbing activities that would impact any previously undisturbed geological units and; therefore, would not result in the permanent loss of, or loss of access to, any paleontological resource of significance. Therefore, no operational impact on paleontological resources would occur.

Per MM GEO-2 and MM GEO-3, implementation of combined paleontological resource mitigation plan with as-needed monitoring and worker training would reduce potentially significant impacts to paleontological resources through the recovery, preparation, deposition, and maintenance of fossil specimens uncovered during ground disturbing activities in an appropriate museum repository. Thus, impacts would be less than significant with mitigation.

### 3.7.4 Mitigation Measures

#### MM GEO-1 Site-Specific Geotechnical Evaluation

Prior to the design and construction of proposed improvements at in each phase of the Project, a detailed geotechnical evaluation, including subsurface exploration and laboratory testing, shall be performed, consistent with LADBS standards and approvals. The geotechnical evaluation shall 1) further evaluate the specific subsurface conditions, including liquefaction and landslide potential, at each development site, 2) provide site-specific data regarding potential geologic and geotechnical constraints, and 3) provide information pertaining to the engineering characteristics of earth materials with regard to the proposed Project. Recommendations for earthwork, excavations, foundations, shoring, pavements, and other pertinent geotechnical design considerations shall be formulated from the detailed geotechnical evaluation. In the California planning area, the proposed hillside cut, excavation, and reinforcement required for Condor Canyon and its potential bridges shall be evaluated and designed with appropriate shoring mechanisms to avoid landslide and soil instability during construction and operation. The recommendations of the geotechnical report shall be incorporated into the final design and construction of the Project components. The geotechnical reports shall analyze for the following hazards:

- If the site-specific geotechnical evaluation finds that slope instability is an issue in certain phases of development such as California and Africa planning area improvements, engineering techniques and technologies as retaining walls or graded soil buttresses, shall be employed during construction and/or operation.
- If the site-specific geotechnical evaluation finds that liquefaction is an issue in certain phases of development such as development of Zoo Entry, Nature Play Park, or Asia planning area improvements or the proposed parking structure, engineering techniques and technologies such as removal and recompaction, densification of existing soils, or deepened foundations shall be employed during construction and operation.
• If the site-specific geotechnical evaluation finds that expansive soils are an issue in certain phases of development such as development of Zoo Entry, Nature Play Park, or Asia planning area improvements, engineering techniques and technologies such as removal and replacement with low expansive materials or special reinforced design of foundations and slabs shall be employed during construction and operation.
• If the site-specific geotechnical evaluation finds that dynamic compaction of dry soils is an issue in certain phases of development, engineering techniques and technologies such as removal and recompacktion, densification of existing soils, or deepened foundations may be employed during construction and operation.

The Zoo shall prepare each geotechnical evaluation for each improvement in Phases 1 – 7 to inform final design and engineering of improvements. Each geotechnical investigation shall be reviewed and approved by LADBS and the City Bureau of Engineering prior to groundbreaking of each phase. LADBS and the City of Bureau of Engineering shall review and approve all geotechnical investigations and review final Zoo development and engineering plans to ensure geotechnical recommendations are accurately incorporated prior to Project-related construction.

**MM GEO-2 Site-specific Paleontological Mitigation Plan**

A qualified paleontologist approved by the City of Los Angeles and the Los Angeles County Natural History Museum Vertebrate Paleontology Department shall be retained prior to earth-moving activities associated with construction of any individual Project phase. Prior to these earth-moving activities, the paleontologist shall determine if a site-specific mitigation plan is required for each phase based on the underlying geology and the proposed depths of excavation proposed by development and engineering plans for each phase. If a site-specific mitigation plan is required, the plan shall specify the level and types of mitigation efforts as set forth below, based on the types and depths of any ground disturbing activities and associated, impacted geological unit.

Where a site-specific mitigation plan is required, earth-moving activities shall be monitored by the paleontologist or a monitor. Monitoring is only required in those areas of the individual development phase where these activities would disturb previously undisturbed geological units and dependent upon the units present. Monitoring shall be conducted on a full-time basis in areas underlain by the Upper Topanga Formation, and at depths greater than 10 feet bgs in areas underlain by Quaternary alluvium. Monitoring shall consist of:

• Visually inspecting debris piles and freshly exposed cuts for larger fossil remains
• Periodic dry screening sediment, rock, and debris for smaller fossil remains
• Recovery of all vertebrate fossil specimens, a representative sample of invertebrate or plant fossils, or any fossiliferous rock sample that may be easily recovered
• Diversion of ground disturbing activities away from large or unusually productive fossil localities for the time that is required to recover the resource by the paleontologist or monitor(s)

• Notification of the paleontologist or monitor (if not on-site) by the construction crew of any unanticipated discoveries of fossil resources. Ground disturbing activities will be temporarily diverted while the paleontologist or monitor assess the resource and determine if recovery is warranted or if ground-disturbing activities may resume in the area.

• Collection of rock or sediment samples of the Upper Topanga Formation or Quaternary alluvium for each construction site for processing for small fossils. The total weight of all processed samples from either rock unit shall not exceed 1,000 pounds (2,000 pounds total). The results of processing initial 250-pound test samples shall be used by the paleontologist in determining how much of the remaining total samples shall be collected and processed. More of the samples shall be processed if the recovered remains are sufficiently concentrated (at least 4-5 identifiable specimens per sample), generally identified to genus or species level, and represent a taxonomically diverse faunal assemblage. With the development of each successive construction site, the paleontologist or monitor, may specify that less than 1,000 pounds shall be processed, based on the amount of excavation and other ground disturbing activities that would occur in areas underlain by the Quaternary alluvium, 10 feet bgs, or Upper Topanga Formation, and on the results of processing samples from the same rock unit at previous construction sites.

• Unless potentially fossilized remains are discovered at or near the surface, no paleontological monitoring of ground disturbing activities in the Quaternary alluvium at depths less than 10 feet bgs, and no samples shall be collected or processed.

• The paleontologist or monitor shall maintain daily monitoring logs that record the tasks accomplished, locations, where ground disturbing activities and monitoring were conducted, geological units encountered, any fossil specimen recovered, and associated specimen data and geologic and geographic site data.

If no fossil remains are found after 50 percent of ground-disturbing activities have been completed in an area underlain by Quaternary alluvium or Upper Topanga Formation, monitoring may be reduced or suspended in the remainder of that area with approval from the City of Los Angeles.

If a site-specific mitigation program is required, the paleontologist shall reach a formal agreement with a recognized museum repository, such as the Los Angeles County Natural History Museum, before the mitigation program begins. The agreement shall include specifications regarding final disposition and permanent storage and maintenance of any fossil specimens recovered as part of the mitigation program as well as archiving associated fossil specimen data and corresponding geologic and geographic site data, and level of treatment/preparation of the fossil specimens. The fossil collection shall be donated to a
public, nonprofit repository with a research interest in the collection. The costs to be charged by the repository for curating and permanently storing the collected fossil specimens shall be specified in the repository agreement.

If paleontological resources are discovered and curated as a result of a required site-specific mitigation program, a final technical report of results and findings shall be prepared by the paleontologist in accordance with City of Los Angeles requirements, as applicable. Copies of the final report and any supporting documentation, including the paleontologist’s or monitor’s field notes and fossil site maps shall be archived at the designated repository. The final report shall be prepared upon completion of ground disturbing activities for the first applicable phase of Project development. Subsequent reports for additional phases shall be issued as addenda to the first final report. Individual projects whose ground disturbing activities are completed within a single calendar year may be addressed collectively in one report or addendum, as applicable.

**MM GEO-3 Worker Paleontological Resource Awareness Program**

Prior to construction of each phase, workers shall receive education regarding the recognition of possible paleontological resources, during grading and excavation. Such training shall provide construction personnel with direction regarding the procedures to be followed in the unlikely event that previously unidentified paleontological materials are discovered during construction. Training shall also inform construction personnel that unauthorized collection or disturbance of paleontological resources is not allowed. The training shall be prepared by a City-approved paleontologist and shall provide a description of paleontological resources that may be encountered in the Project site, outline steps to follow in the event that a discovery is made, and provide contact information for the Project paleontologist and appropriate City personnel. The training shall be conducted concurrent with other environmental or safety awareness and education programs for the Project, provided that the program elements pertaining to paleontological resources is provided by a qualified instructor meeting applicable professional qualifications standards. To prevent inadvertent potential significant impacts to paleontological resources that may be encountered during ground disturbance or construction activities, in the event of any inadvertent discovery of paleontological resources during construction, all work within the vicinity of the resource established by the City-approved paleontologist shall temporarily cease. If a paleontological resource is discovered, the City-approved paleontologist shall be notified to assess the significance of the find and provide recommendations as necessary for its proper disposition and the need for a site-specific mitigation plan, consistent with MM GEO-2.

**3.7.5 Impacts Summary**

Geology, soils, and paleontological impacts would be less than significant with implementation of the above identified mitigation measures. There would be no unavoidable adverse geological impacts associated with the proposed Project.