5.6 GEOLOGY AND SOILS

This section of the updated Draft Program Environmental Impact Report (PEIR) evaluates the potential for implementation of the Santa Ana General Plan Update to impact geological and soil resources, paleontological resources, or unique geologic features in Santa Ana and its sphere of influence (plan area). The analysis in this section is based in part on the following technical report(s):

- *Geological Background Technical Report for the General Plan Update*, PlaceWorks, May 2020
- *Paleontological Existing Conditions Technical Report for the City of Santa Ana General Plan Update*, SWCA Environmental Consultants, April 2019

Complete copies of these studies are included in the technical appendices (Volume III, Appendices G-a, G-b).

5.6.1 Environmental Setting

5.6.1.1 REGULATORY BACKGROUND

Santa Ana's regulatory framework for geologic and seismic hazards includes state law, the general plan, and municipal code requirements. These primary regulations are described as follows.

Alquist-Priolo Earthquake Fault Zone

The Alquist-Priolo (AP) Earthquake Fault Zoning Act of 1972 was intended to mitigate the hazard of surface fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. The act delineates "Earthquake Fault Zones" along faults that are "sufficiently active" and "well defined." The act also 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. Pursuant to this act, structures for human occupancy are not allowed within 50 feet of the trace of an active fault. As described later, no AP zones are delineated in Santa Ana.

Seismic Hazard Mapping Act

Earthquakes can cause significant damage even if surface ruptures do not occur. The Seismic Hazard Mapping Act (SHMA) of 1990 was intended to protect the public from the hazards of nonsurface fault rupture from earthquakes, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure. The California Geological Survey prepares and provides local governments with seismic hazard zone maps that identify areas susceptible to nonsurface fault hazards. SHMA requires responsible agencies to approve projects within seismic hazard zones only after a site-specific investigation to determine if the hazard is present, and the inclusion, if a hazard is found, of appropriate mitigation(s). Orange County has been issued maps showing nonsurface fault hazards, discussed later in this chapter.

The National Environmental Policy Act of 1969

The National Environmental Policy Act of 1969 recognizes the continuing responsibility of the federal government to "preserve important historic, cultural, and natural aspects of our national heritage" ([42 US Code § 4321]). With the passage of the Paleontological Resources Preservation Act, paleontological resources are considered a significant resource, and it is therefore now standard practice to include paleontological resources in National Environmental Policy Act studies in all instances where there is a possible impact.

Antiquities Act of 1906

The Antiquities Act of 1906 (16 US Code §§ 431–433) prohibits appropriation, excavation, or destruction of any object of antiquity, which has been interpreted to include fossils by federal agencies. However, the act does not specifically mention paleontological resources, so agencies are hesitant to interpret this act as governing paleontological resources on lands not administered by federal agencies.

California Building Code

Every public agency enforcing building regulations must adopt the provisions of the California Building Code (CBC), which is Title 24, Part 2 of the California Code of Regulations. The most recent version is the 2019 CBC (effective January 1, 2020). The CBC is updated every three years and 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 also contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock on-site, and the strength of ground shaking with specified probability of occurring at a site. A city may adopt more restrictive codes than state law based on conditions in their community.

Government Codes for Specific Building Types

While the CBC regulates the design and construction of most buildings and structures in a community, certain facilities have additional requirements from state and federal agencies. These include hospitals, schools, essential facilities, and lifeline infrastructure.

- **Acute care hospitals.** These facilities are required to meet the standards of the Alquist Hospital Seismic Act.
- **Public schools.** Public schools that are being constructed or rehabilitated are required to comply with standards under the Field Act, Division of State Architectural standards, and California Education Code Section 17317.
- **Essential facilities.** Essential facilities (police, fire, emergency community facilities, etc.) must comply with the additional standards and requirements of the Essential Services Building Seismic Safety Act.

- **Lifeline infrastructure.** Bridges, utilities, dams/reservoirs, and other infrastructure must adhere to regulations of the Department of Water Resources, Department of Transportation, and Public Utilities Commission.

Mobile Home Parks and the Special Occupancy Parks Act

Mobile homes are prefabricated homes placed on piers, jack stands, or masonry block foundations. Floors and roofs are usually plywood, and outside surfaces are covered with sheet metal. Severe damage can occur when mobile homes fall off their supports, severing utility lines and piercing the floor with jack stands. The California Health and Safety Code governs mobile homes and special-occupancy parks. In 2011, regulations were adopted that address park construction, maintenance, use, occupancy, and design. However, the amendments do not require earthquake-resistant bracing systems. Because the city has nearly 4,000 mobile homes (many of which are occupied by seniors) and mobile homes generally fare poorly in earthquakes, ensuring the safety of mobile home occupants is a concern.

California General Plan Law and General Plan Guidelines

State law (Government Code § 65302) requires cities to adopt a comprehensive long-term general plan that includes a safety element. The safety element is intended to provide guidance for protecting the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; other seismic hazards identified by Public Resources Code (PRC) Sections 2691 et. seq.; and other geologic hazards known to the legislative body. The seismic safety element must also include mapping of known seismic and geologic hazards from the California Geological Survey and a series of responsive goals, policies, and implementation programs to improve public safety.

California Environmental Quality Act

CEQA is the principal statute governing environmental review of projects occurring in the state and is codified at PRC Sections 21000 et seq. CEQA requires lead agencies to determine if a proposed project would have a significant effect on the environment, including significant effects on paleontological resources. Guidelines for the implementation of CEQA, as amended (California Code of Regulations §§ 15000 et seq.), define procedures, types of activities, persons, and public agencies required to comply with CEQA and include as one of the questions in the Environmental Checklist: "Will the proposed project directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?" (§ 15023; Appendix G).

Public Resources Code Section 5097.5

Requirements for paleontological resource management are included in PRC Sections 5097.5 and 30244. These statutes prohibit the removal of any paleontological site or feature without permission. As a result, local agencies are required to comply with PRC Section 5097.5 for permit action, construction, and maintenance activities. PRC Section 5097.5 also establishes the removal of paleontological resources as a misdemeanor and requires reasonable mitigation of adverse impacts to paleontological resources from developments on public (state, county, city, and district) lands.

Santa Ana Municipal Code

The Santa Ana Municipal Code and other City development policies and procedures provide guidance on addressing specific geologic and seismic hazards in Santa Ana. Among others, these include:

Chapter 8, Buildings and Structures. These codes address grading standards, excavation, and fills. This also includes compliance with regulations for unreinforced masonry structures in accordance with "Unreinforced Masonry Law" in California Government Code §§ 8875 et seq.

The City of Santa Ana Building Official may put additional requirements on the construction of infrastructure, buildings, and other improvements based on the findings from plan check, soils testing, and geotechnical investigations.

5.6.1.2 EXISTING CONDITIONS

This section describes the local geologic setting and associated seismic and geologic hazards associated with the city's location, topography, soils, and faulting.

Geologic Setting

The City of Santa Ana is on the southern portion of the Downey Plain, a broad alluvial plain that covers the northwestern portion of Orange County (Yerkes et al. 1965). Santa Ana is situated within the Peninsular Ranges Geomorphic Province, which extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin to the southern tip of Baja California. The province varies in width from approximately 30 to 100 miles. In general, the province consists of a complex of blocks oriented northwest-southeast and separated by similarly trending faults.

Santa Ana is underlain by Holocene and Pleistocene alluvial deposits and early Pleistocene marine deposits (Morton 2004). Below these deposits lie Miocene and late Cretaceous sedimentary rocks. The Santa Ana Mountains rise to 5,700 feet above sea level northeast and east of the City, and the San Joaquin Hills are to the southeast (Google Earth Pro 2019). The Santa Ana River flows through the western portion of the city on its way to the Pacific Ocean to the southwest. Santa Ana is generally flat with a gentle slope toward the southwest (USGS 2015a, 2015b, 2015c, 2015d).

The Peninsular Ranges Geomorphic Province is traversed by a group of subparallel and fault zones trending roughly northwest. Major active fault systems—San Andreas, San Jacinto, Whittier-Elsinore, and Newport-Inglewood fault zones—form a regional tectonic framework consisting primarily of right-lateral, strike-slip movement (Jennings & Bryant 2010). Santa Ana is situated between two major active fault zones—the Whittier-Elsinore Fault Zone to the northeast and the Newport-Inglewood Fault to the southwest. Other potentially active faults near Santa Ana include the Elysian Park blind thrust; Chino-Central Avenue, San Joaquin Hills blind thrust, and San Jose, Cucamonga, Sierra Madre, and Palos Verdes faults (CGS 2019; Cao et al. 2003).

The Richter Scale is used to describe the magnitude of an earthquake. Each one-point increase in magnitude (M) represents a 10-fold increase in earthquake wave size and a 30-fold increase in energy release (strength). For example, an M8 earthquake produces 10 times the ground motion amplitude of an M7 earthquake, 100 times that of an M6 quake, and 1,000 times the motion of a magnitude 5. However, the M8 earthquake is 27,000 times stronger than an M5 quake. Typically, earthquakes of M5 or greater are considered strong earthquakes capable of producing damage.

Table 5.6-1 provides a summary of the key faults that could produce significant earthquakes (exceeding M5) that could impact Santa Ana. The table also includes the maximum associated magnitudes of earthquakes along each fault. Figure 5.6-1 shows the location of fault hazards and their proximity to Santa Ana.

Table 5.6-1 Earthquake Faults Near Santa Ana

Fault	Description of Earthquake Fault Zone	Maximum Hazard
Newport-Inglewood	The Newport-Inglewood Fault Zone consists of a series of disconnected, northwest-trending fault segments which extend from Los Angeles, through Long Beach and Torrance, to Newport Beach and offshore south past Oceanside. Although no major rupture has occurred since the 1933 Long Beach quake (6.4 M), the fault is considered active and is zoned under the Alquist-Priolo Earthquake Fault Zone Act. The fault is located about four miles from the City.	M 7.1
Whittier Fault Zone	The Whittier Fault Zone extends from Whittier Narrows in Los Angeles County, southeasterly to Santa Ana Canyon where it merges with the Elsinore Fault Zone. The Whittier Fault Zone is located about nine miles from the northern edge of the City. The Whittier Fault is active and is zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 6.8
Elsinore Glen Ivy Segment	The Glen Ivy segment of the Elsinore Fault Zone is located about twelve miles from the City. Dominant movement along this fault is right-lateral strike-slip. The Glen Ivy segment is zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 6.8
San Joaquin Hills Blind Thrust	Located at depth about a mile southeast of the City, the San Joaquin Hills Blind Thrust Fault is approximately 17 miles long and is characterized by reverse dip-slip movement. This fault is responsible for the uplift of the San Joaquin Hills. The San Joaquin Hills Blind Thrust Fault is considered active and is not zoned under the Alquist-Priolo Earthquake Zone Act.	M 6.6
Chino-Central Avenue	The Chino-Central Avenue Fault branches away from the Elsinore (Glen Ivy) Fault and extends northwest 13 miles through the Prado Basin and into the Puente Hills. Dominant movement along the fault is right-lateral reverse oblique slip. The Chino Fault is about 14 miles northeast of the City and is zoned under the Alquist-Priolo Earthquake Zone Act.	M 6.7
Puente Hills Blind Thrust	Located at depth about ten miles northwest of the City, the Puente Hills Blind Thrust Fault is approximately 27 miles long and is characterized by reverse dip-slip movement. The Puente Hills Blind Thrust Fault is considered active and is no zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 7.1
Upper Elysian Park Blind Thrust	The Upper Elysian Park Blind Thrust Fault is located at depth about ten miles north of the City. The fault is approximately 12 miles long and is characterized by reverse dip-slip movement. The Upper Elysian Park Blind Thrust Fault is considered active and is not zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 6.4
San Jose	The San Jose Fault is 12 miles long, extending southwest and west from near the mouth of San Antonio Canyon on the southern front of the San Gabriel Mountains about 21 miles north of the City. The fault is characterized by left-lateral reverse oblique-slip movement, and was responsible for the 1990 M 5.4 Upland earthquake.	M 6.9
Cucamonga	The Cucamonga Fault is the eastward extension of the Sierra Madre Fault Zone and is located 26 miles northeast of the City, extending 17 miles long, from Duncan Canyon to San Antonio Heights along the San Gabriel Mountains. The fault is characterized by reverse dip-slip movement. The Fault is active and within an Alquist-Priolo Earthquake Fault Zone.	M 6.9

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Table 5.6-1 Earthquake Faults Near Santa Ana

Fault	Description of Earthquake Fault Zone	Maximum Hazard
San Jacinto	The San Jacinto Fault, located about 36 miles northeast of the City, is considered to be the most active fault in southern California. The fault zone extends 130 miles and is characterized by right-lateral strike-slip movement. The San Jacinto Fault is considered active and is capable of a maximum moment magnitude 6.9 earthquake. The fault is zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 6.9
Sierra Madre Fault Zone	Located 24 miles north of the City, this fault zone extends 35 miles long, from Claremont and following the southern front of the San Gabriel Mountains to San Fernando. This fault zone is characterized by reverse dip-slip movement. The western portion of the Sierra Madre Fault is zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 7.2
Palos Verdes	The Palos Verdes Fault is located offshore about 16 miles southwest of the City. The fault zone extends for about 50 miles southeast from the northern front of the Palos Verdes Peninsula. The fault zone is characterized by reverse right-lateral oblique-slip movement. The fault is not zoned under the Alquist-Priolo Earthquake Fault Zone Act.	M 7.3
San Andreas	The San Bernardino and Southern segments of the San Andreas Fault are located about 40 miles northeast of the City. Past work estimates that the recurrence interval for a M 8.0 earthquake along the entire fault zone is 50–200 years, and a 140–200 year recurrence interval for a M 7.0 earthquakes along the southern fault zone segment.	M 7.5+

Source: Cao et al. 2003.

Seismic Hazards

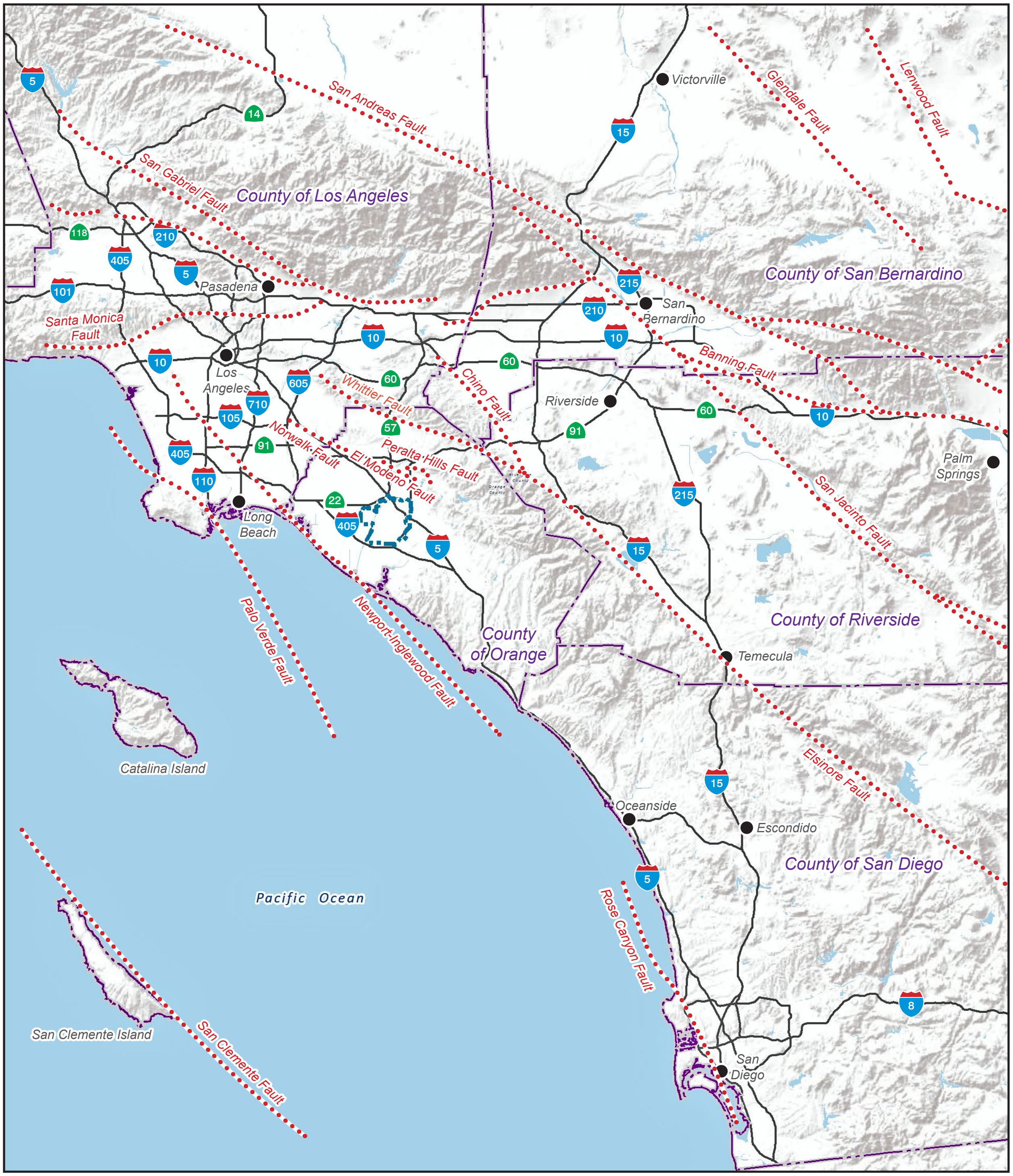
Historically, Santa Ana has only experienced one major destructive earthquake, which was the 1933 M 6.4 Long Beach earthquake, which affected and destroyed many structures in the downtown portion of Santa Ana. In addition, based on a search of earthquake databases of the United States Geological Survey (USGS) National Earthquake Information Center, several major earthquakes (magnitude 5.8 or more) have been recorded within approximately 60 miles of the city since 1769 (USGS 2019). The latest of these were the Northridge earthquake and Granada Hills aftershock in 1994, about 60 miles from the city.

The primary seismic hazards related to earthquakes are summarized.

Surface (Fault) Rupture

Seismic activity has been known to cause surface rupture, or ground displacement, along a fault or within the general vicinity of a fault zone. In accordance with the Alquist-Priolo Earthquake Fault Zoning Act (AP Zoning Act), the State Geologist has established fault zones along known active faults in California. No active surface faults are mapped and zoned under the AP Zoning Act in Santa Ana (CGS 2019).

Figure 5.6-1 - Regional Fault Map



City of Santa Ana

Fault Line

Note: All fault locations and dimensions are approximate and not all faults are shown.
Source: California Department of Mines and Geology. Preliminary fault activity map of California, 1994.

0 20
Scale (Miles)

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Primary ground rupture usually results in a relatively small percentage of the damage caused by an earthquake. Primary fault rupture is rarely confined to one fault; it often spreads out into complex patterns of secondary faulting and ground deformation. Secondary faulting involves a web of interconnected faults that rupture in response to a primary rupture. Secondary ground deformation can include fracturing, shattering, warping, tilting, uplift, and/or subsidence. Such deformation may be relatively confined along the rupturing fault or spread over a large region. Deformation and secondary faulting can also occur without primary ground rupture, as in the case of ground deformation above a blind (buried) thrust fault.

Strong Seismic Ground Shaking

Ground shaking refers to vibration of the ground from an earthquake. Shaking above Magnitude 5 on the Richter Scale is known to damage structures. Earthquakes are common to southern California, and geologic evidence is used to determine the likelihood and magnitude of ruptures along a fault. Peak horizontal ground acceleration (PHGA) values that could be expected in Santa Ana are based on types and characteristics of fault sources, distances and estimated maximum earthquake magnitude, and subsurface site geology. The PHGA estimate depends on the method of determination. The maximum magnitude (Mmax) is considered the largest earthquake expected to occur along a fault and is based in part on fault characteristics (length, style of faulting, and historic seismicity). The Newport-Inglewood Fault is the dominant active fault that could significantly impact the city.

Ground motion will generally amplify as it passes from the bedrock and through the softer, deep alluvial deposits. The PHGA at the surface of a site depends substantially on the thickness of sedimentary deposits beneath the site. Based on USGS estimates for the Santa Ana area and a 1.0-second spectral acceleration, site effects from the geologic units underlying the city may have three times the effect of crystalline bedrock at the same location.

Liquefaction and Related Ground Failure

Liquefaction happens when 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. Surface ground failure is usually expressed as lateral spreading, flow failures, ground oscillation, and/or general loss of bearing strength. Sand boils (injections of fluidized sediment) commonly accompany these different types of failure. Liquefaction can damage building foundations, structures, and infrastructure, leading to collapse.

Susceptibility to liquefaction typically depends on: 1) the intensity and duration of ground shaking; 2) the age and textural characteristic of the alluvial sediments; and 3) the depth to the groundwater. Loose, granular materials at depths of less than 50 feet, with silt and clay contents of less than 30 percent, and saturated by relatively shallow groundwater table are most susceptible to liquefaction. These geological conditions are typical in parts of southern California, in valley regions and alluvial floodplains. In Santa Ana, most of the city is in areas that are susceptible to liquefaction, including the southern half of the city and along the margins of Santiago Creek and the Santa Ana River (CGS 2019) (see Figure 5.6-2, *Liquefaction Zones*).

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Slope Failure (Landslides)

Landslides are perceptible downward movements of soil, debris, rock, or a combination of these under the influence of gravity. Landslide materials are commonly porous and very weathered in the upper portions and margins of the slide. They may also have open fractures or joints. Slope failures can occur during or after periods of intense rainfall or in response to strong seismic shaking. Landslides are distinguished from minor debris flows because in a landslide, the majority of material moved is bedrock materials, and a minor debris flow is the surface slippage of soil. Fire events in areas of high topographic relief can lead to conditions conducive to debris flows.

Landslides, debris flows, or any movement of earth or rock are most common in areas of high topographic relief, such as steep canyon walls or steep hillsides. Because the entire city is nearly flat, landslides are not a major hazard in Santa Ana (USGS 2015a, 2015b, 2015c, 2015d).

Geologic Hazards

Based on available studies, the geologic hazards most likely in Santa Ana include expansive soils, corrosive soils, and settlement/collapsible soils (to a lesser degree). Each of these potential hazards is discussed below, accompanied with figures where necessary.

Expansive Soils

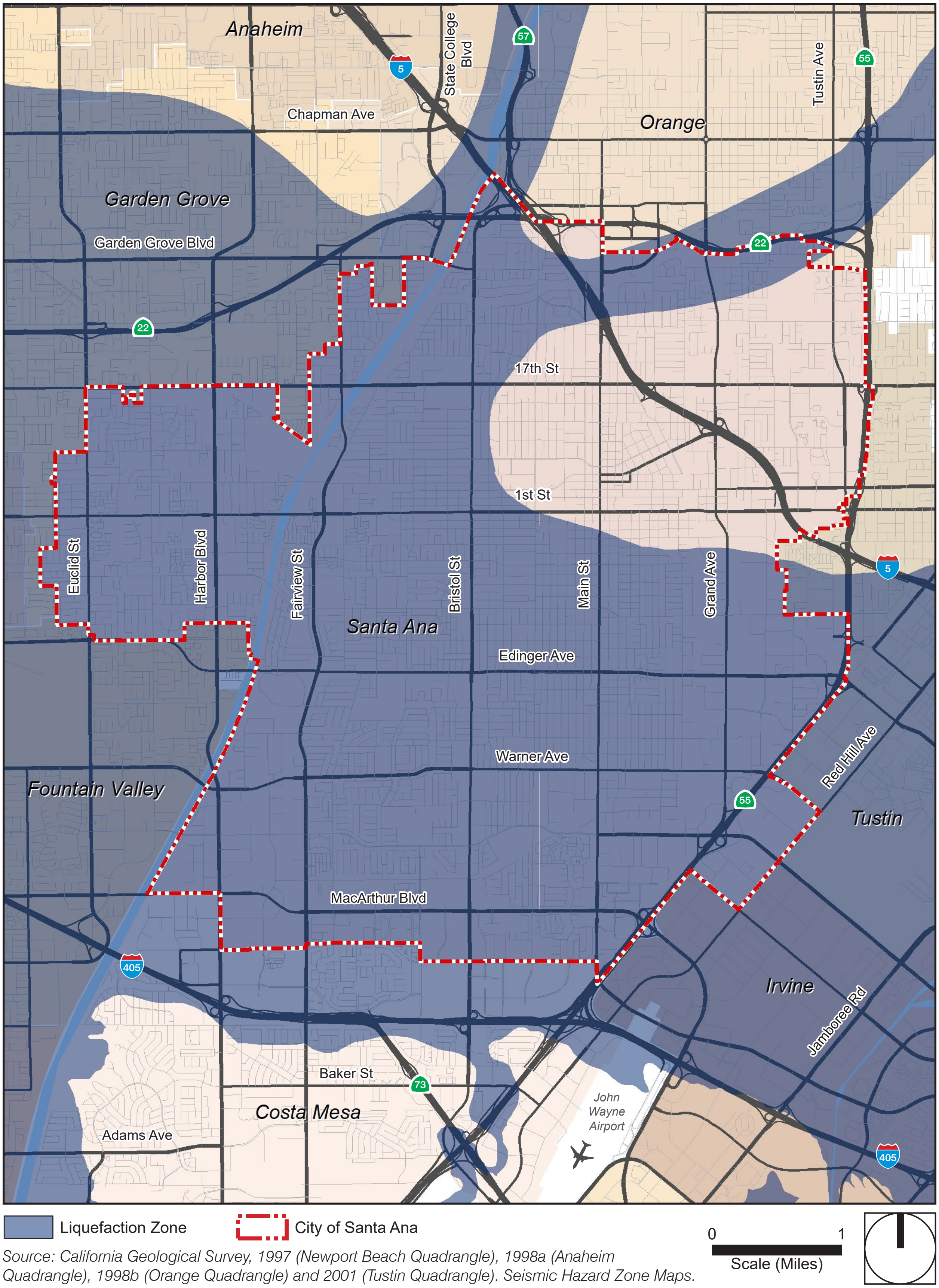
Expansive and collapsible soils are two of the most widely distributed and costly of geologic hazards. Expansive soils will shrink or swell as the moisture content decreases or increases. Expansive soil and rock are typically characterized by clayey material that shrinks as it dries and swells as it becomes wet. Homes, infrastructure, and other structures built on these soils may experience shifting, cracking, and breaking as soils shrink and subside or expand. Expansive soils are also known to cause damage to the foundation of structures.

Based on the presence of alluvial materials in the city, there is some potential for expansive soils throughout Santa Ana (Morton 2004; USDA 1978). Expansive soils are possible wherever clays and elastic silts may be present, including alluvial soils, weathered granitic, and fine-grained sedimentary rocks. Expansive soils are tested prior to grading as part of a soil engineering report—as required by the CBC and the City of Santa Ana—and are mitigated as necessary.

Corrosive Soils

Corrosive soils contain chemical constituents that may cause damage to construction materials such as concrete and ferrous metals. One such constituent is water-soluble sulfate, which, if in high enough concentrations, can react with and damage concrete. Electrical resistivity, chloride content, and pH level are all indicators of a soil's tendency to corrode ferrous metals. High chloride concentrations from saline minerals can corrode metals (carbon steel, zinc, aluminum, and copper). Low pH and/or low resistivity soils could corrode buried or partially buried metal structures.

Figure 5.6-2 - Liquefaction Zones



Source: California Geological Survey, 1997 (Newport Beach Quadrangle), 1998a (Anaheim Quadrangle), 1998b (Orange Quadrangle) and 2001 (Tustin Quadrangle). Seismic Hazard Zone Maps.

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Soils throughout the majority of Santa Ana have been found to be highly corrosive to metals and marginally to moderately corrosive to concrete. Typical mitigation for corrosive soil includes corrosion-resistant coatings. Corrosive soils for concrete and/or metals are often addressed through techniques that include cathodic protection, use of special concrete overlays, and other techniques. The City's Engineering Standards require that proposed projects include soil investigations and cathodic protection for metal piping when corrosive soils are encountered.

Land Subsidence

Land sinking or subsidence is generally related to substantial overdraft of groundwater reserves from underground reservoirs. Santa Ana has shown historical subsidence, and it is considered a potential hazard for the City (Riel et al. 2018). Subsidence in Santa Ana does not show a pattern of widespread, irreversible lowering of the ground surface. The probability of subsidence is generally low in the majority of Santa Ana, with the most susceptible areas along the margins of the Santa Ana River and Santiago Creek. Groundwater storage by Orange County Water District and statutory commitments to sustainable groundwater management practices reduce the potential for future land subsidence, and ongoing surveying of the ground surface by Orange County Water District provides a way to verify that their efforts in preventing subsidence are effective (OCWD 2015).

Settlement and/or Collapse

The potential hazard posed by seismic settlement and/or collapse in the city is considered moderate based on the compressibility of the underlying alluvial soils and the presence of shallow groundwater (CGS 2019). Strong ground shaking can cause settlement of alluvial soils and artificial fills if they are not adequately compacted. Because unconsolidated soils and undocumented fill material are present in the City, seismically induced settlement and/or collapse are possible (Morton 2004). Site-specific mass grading and compaction, which would occur as part of future development, would mitigate any potential impacts from settlement and/or collapse in the city.

Paleontological Setting

Paleontological resources are fossils—that is, organisms or fragments, impressions, or traces of organisms preserved in rock. Santa Ana is in the northwestern Peninsular Ranges Geomorphic Province, one of the largest geologic regions in western North America (Norris and Webb 1990). Locally, the project area lies within the alluvial valley of the Santa Ana River on the Perris Block, characterized by widespread alluvial fan deposits originating from the San Gabriel Mountains to the east of the project area and dating to the late Pleistocene. Geologic mapping by Morton and Miller (2006) indicates the surficial geology of Santa Ana is composed of alluvial sediments that range in age from the Holocene to early Pleistocene.

Pleistocene sediments have a rich fossil history in southern California. (SWCA 2019) The most common Pleistocene terrestrial mammal fossils include the bones of mammoth, horse, bison, camel, and small mammals, but other taxa, including lion, cheetah, wolf, antelope, peccary, mastodon, capybara, and giant ground sloth, have been reported, as well as birds, amphibians, and reptiles such as frogs, salamanders, snakes, and turtles. In addition to illuminating the striking differences between southern California in the Pleistocene and today, this abundant fossil record has been vital in studies of extinction, ecology, and climate change.

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Although there were no records of fossils from within the plan area, the Natural History Museum of Los Angeles County (LACM) has records of 16 fossil localities within a five-mile radius of the city (Table 5.6-2) with the closest fossil locality approximately 2.5 miles south of the City. Throughout Orange County, extinct Pleistocene animals are well known from alluvial sediments. Columbian mammoths, American mastodons, ground sloths, short-faced bears, American lions, saber-toothed cats, dire wolves, horses, tapirs, ancient bison, long-horned bison, camels, llamas, and dwarf pronghorns have been recovered. Ice Age fossils begin appearing at a depth of 8 to 10 feet below the ground surface in southern California valleys.

Table 5.6-2 LACM Pleistocene-Aged Fossil Localities in the Vicinity of Santa Ana

Locality Number	Depth (in feet below the ground surface)	Specimens
LACM 1339	15	Mammoth, camel
LACM 4219	NA	Sea turtle, camel
LACM 3267	NA	Elephant
LACM 6370	NA	Horse
LACM 1652	NA	Sheep
LACM 4943	8–10	Horse
LACM 65113	6–20	Mammoth, bison
LACM multiple (9)	NA	Sea otter, pallid bat, shrews, pocket gopher

Source: SWCA 2019.

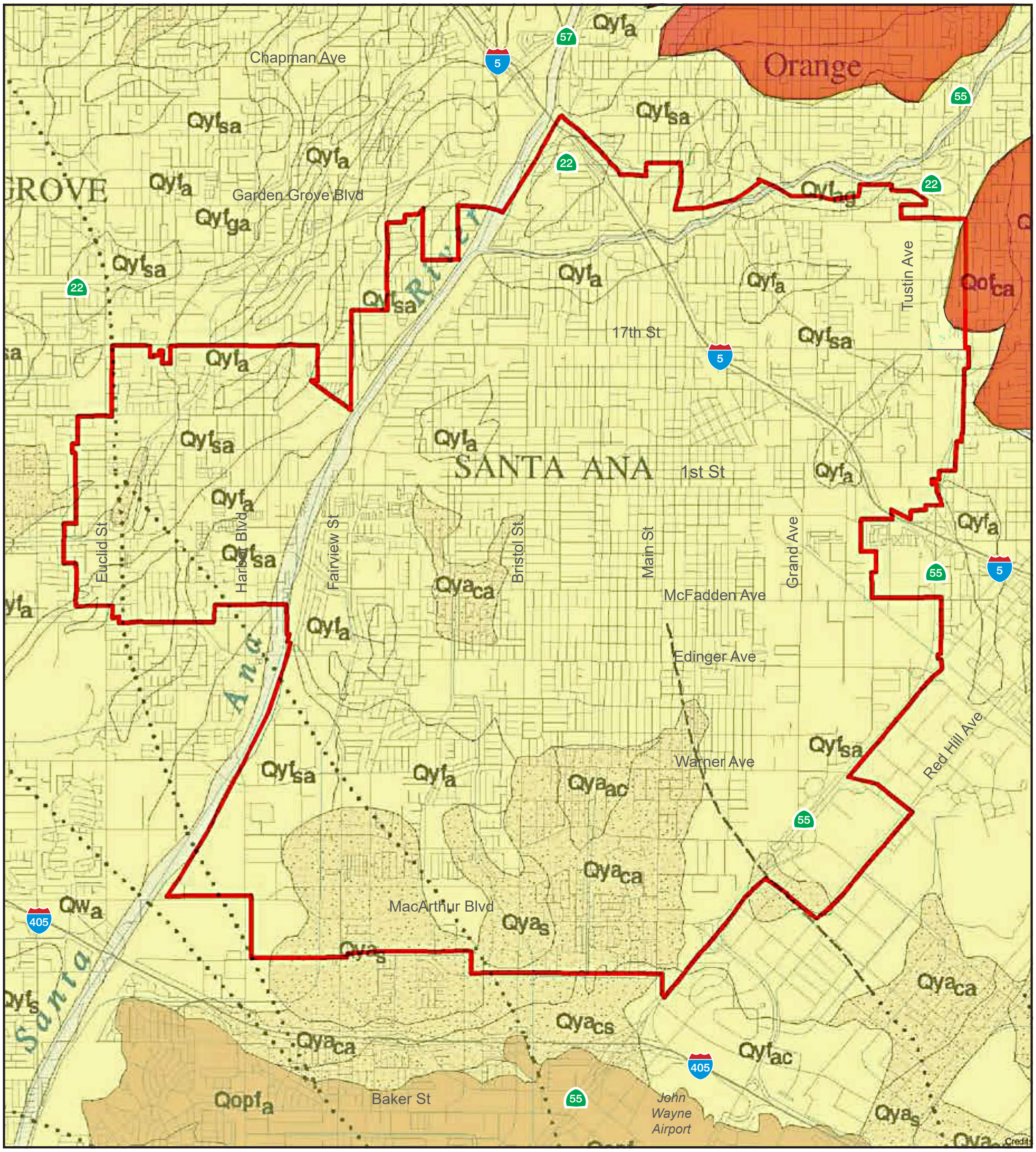
The paleontological existing conditions report for the proposed project assigned paleontological sensitivity rankings to each geologic unit in Santa Ana (see Table 5.6-3 and Figure 5.6-3).

Table 5.6-3 Paleontological Sensitivity of Geologic Units in Santa Ana

Geologic Unit	Age	Occurrence	Sensitivity
Young alluvial fan deposits	Holocene – late Pleistocene	Surface, majority of city	Low-to-High, increasing with depth
Young axial- channel deposits	Holocene – late Pleistocene	Surface, southern part of city	Low-to-High, increasing with depth
Old alluvial fan deposits	Late – middle Pleistocene	Surface, northeastern-most city; Subsurface, throughout city	High

Source: SWCA 2019.

Figure 5.6-3 - Paleontological Sensitivity



City of Santa Ana

Paleo Sensitivity

High Sensitivity

Low-to-High Sensitivity, Increasing with Depth

0 1
Scale (Miles)

Source: SWCA, 2019

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5.6.2 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.

5.6.3 Regulatory Requirements and General Plan Policies

5.6.3.1 REGULATORY REQUIREMENTS

RR G-1 Every public agency enforcing building regulations must adopt the provisions of the California Building Code (CBC), which is Title 24, Part 2 of the California Code of Regulations. The most recent version is the 2019 CBC (effective January 1, 2020). The CBC is updated every three years and 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 also contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock on-site, and the strength of ground shaking with specified probability of occurring at a site.

RR G-2 Santa Ana Municipal Code, Chapter 8, Buildings and Structures. These codes address grading standards, excavation, and fills. This also includes compliance with regulations for unreinforced masonry structures in accordance with "Unreinforced Masonry Law," found in California Government Code §§ 8875 et seq. The City of Santa Ana Building Official may place additional requirements upon the construction of infrastructure, buildings, and other improvements based on the findings from plan check, soils testing, and geotechnical investigations.

RR G-3 Santa Ana Municipal Code Section 39-51 requires that all buildings or structures within the city that require plumbing fixtures must be connected to a public sewer.

5.6.3.2 GENERAL PLAN UPDATE POLICIES

The following are relevant policies of the Santa Ana General Plan Update, which may contribute to reducing potential geology and soils impacts.

Conservation Element

- **Policy 2.1 Native Wildlife Habitat Protection.** Protect and enhance natural vegetation in parks and open spaces for wildlife habitat, erosion control, and to serve as noise and scenic buffers.
- **Policy 2.3 Resource Management.** Efficiently manage soil and mineral resource operations to eliminate significant nuisances, hazards, or adverse environmental effects on neighboring land uses.
- **Policy 3.2 Education Programs.** Support education programs to provide information on energy conservation and alternatives to non-renewable energy sources.
- **Policy 4.1 Water Use.** Encourage and educate residents, business owners, and operators of public facilities to use water wisely and efficiently.
- **Policy 4.2 Landscaping.** Encourage public and private property owners to plant native or drought-tolerant vegetation.
- **Policy 4.3 Recycled Water Systems.** Continue to coordinate with the Orange County Water District, Orange County Sanitation District, and developers for opportunities to expand use of reclaimed water systems.
- **Policy 4.4 Irrigation Systems.** Promote irrigation and rainwater capture systems that conserve water to support a sustainable community.
- **Policy 4.5 Water Supply.** Continue to collaborate with Orange County Water District and Metropolitan Water District to ensure reliable, adequate, and high quality sources of water supply at a reasonable cost.
- **Policy 4.6 Water Quality.** Work with public and private property owners to reduce storm water runoff and to protect the water quality percolating into the aquifer and into any established waterway.

Land Use Element

- **Policy 4.3 Sustainable Land Use Strategies.** Encourage land uses and strategies that reduce energy and water consumption, waste and noise generation, soil contamination, air quality impacts, and light pollution.
- **Policy 4.4 Natural Resource Capture.** Encourage the use of natural processes to capture rainwater runoff, sustainable electric power, and passive climate control.

Open Space Element

- ~~**Policy 1.6 Sustainable Landscape.** Promote citywide use of drought tolerant landscape and development practices for wise water use and energy consumption.~~

Public Services Element

- **Policy 2.2 Code Compliance.** Require all development to comply with the provisions of the most recently adopted fire and building codes and maintain an ongoing fire inspection program to reduce fire hazards.
- **Policy 3.4 Drainage Facilities.** Expand and maintain storm drain facilities to accommodate the needs of existing and planned development.
- **Policy 3.2 Wastewater Service.** Provide and maintain wastewater collection facilities which adequately serve existing land uses and future development projects while maximizing cost efficiency.
- **Policy 3.7 Emergency Connections.** Maintain emergency connections with local and regional water suppliers in the event of delivery disruption.
- **Policy 3.8 Conservation Strategies.** ~~Implement~~ Promote cost effective conservation strategies and programs that increase water use efficiency.
- **Policy 3.12 Sewer and Water.** Maintain and upgrade sewer and water infrastructure through impact fees from new development and exploring other funding sources.

Safety Element

- **Policy 1.6 Alternative Flood Control Methods.** Explore and encourage natural flood control infrastructure and techniques that create new open areas to capture storm water, recharge aquifers, prevent flooding, and that expand recreation opportunities.
- **Policy 1.7 Surface Water Infiltration.** Encourage site drainage features that reduce impermeable surface area, increase surface water infiltration, and minimize surface water runoff during storm events on private and public developments.
- **Policy 3.1 Hazard Identification.** Explore opportunities to identify and encourage the upgrade of structures and facilities that are at risk from seismic hazards.

- **Policy 3.2 Seismic and Geotechnical Standards.** Ensure that all new development abides by the current city and state seismic and geotechnical requirements and that projects located in areas with potential for geologic or seismic hazards prepare a hazards study.
- **Policy 3.3 Key Public Facilities and Systems.** Coordinate with relevant utility service providers to ensure that major utility systems remains resilient in the event of a major earthquake and are seismically upgraded.
- **Policy 3.4 Multiagency Education Campaign.** Develop cooperative partnerships and strengthen communication among public agencies, residents, nonprofit organizations, and businesses to promote sharing of educational information regarding seismic and geologic hazards and safety.

5.6.4 Environmental Impacts

The following impact analysis addresses thresholds of significance for which the Notice of Preparation disclosed potentially significant impacts. The applicable thresholds are identified in brackets after the impact statement.

Impact 5.6-1: Plan area residents or occupants, visitors, etc. would be subject to potential seismic-related hazards. [Threshold G-1i, G-1ii, G-1iii and G-1iv])

The plan area's location and underlying geology make it likely to experience seismic hazards, including strong seismic ground shaking, and secondary hazards, like liquefaction.

Earthquake Faults

As stated in Section 5.6.1.2, no active surface faults are mapped and zoned under the AP Zoning Act in the plan area. Therefore, it would not experience surface rupture in the event of an earthquake.

Strong Seismic Ground Shaking

Ground shaking is responsible for most of the damage from earthquakes and can damage or destroy buildings, structures, pipelines, and infrastructure. The intensity of shaking depends on the type of fault, distance to the epicenter, magnitude of the earthquake, and subsurface geology. The Newport-Inglewood Fault southwest of the city is potentially capable of producing the most intense ground accelerations. The seismic design of buildings within the plan area is governed by the requirements of the most recent CBC. The CBC has been accepted as the basic design standard in Santa Ana. All structures that would be constructed in accordance with the General Plan Update would be designed to meet or exceed current design standards as found in the latest CBC. Therefore, new structures are expected to remain standing, but may suffer damage requiring closure and replacement. These project design measures would reduce the exposure of people and structures to harm from strong ground shaking hazards such that there would not be a significant impact.

Seismic-Related Ground Failure

Secondary effects of earthquakes are nontectonic processes such as ground deformation, including fissures, settlement, displacement, and loss of bearing strength, and are the leading causes of damage to structures during a moderate to large earthquake. Secondary effects could lead to ground deformation including liquefaction, lateral spreading, seismically induced landslides, and ground lurching.

As shown in Figure 5.6-2, most of the plan area is within an area susceptible to liquefaction. All structures constructed following the General Plan Update would be designed in accordance with current seismic design standards as found in the CBC. Design measures would be implemented according to the most recent CBC, which would reduce the impact of liquefaction and seismic settlement, including, but not limited to, ground improvement techniques such as in-situ densification, load transfer to underlying nonliquefiable bearing layers, and over-excavation and recompaction with engineered fill method. These design measures would reduce the potential exposure of people and structures to the hazard from liquefaction and seismic settlement such that there would not be a significant impact.

Landslides

Marginally stable slopes (including existing landslides) may be subject to landslides caused by earthquakes. The landslide hazard depends on many factors, including existing slope stability, shaking potential, and presence of existing landslides. Landslides, debris flows, or any movement of earth or rock are most common in areas of high topographic relief, such as steep canyon walls or steep hillsides. There are no substantial hazards with respect to slope stability, as the plan area is mostly flat. There would not be a significant impact from slope stability.

Level of Significance Before Mitigation: With the implementation of RR G-1, Public Services Policies 2.2 and 3.7, and Safety Policies 3.1 through 3.4, Impact 5.6-1 will be less than significant.

Impact 5.6-2: Unstable geologic unit or soils conditions, including soil erosion, could result from development of the General Plan Update. [Thresholds G-2, G-3 and G-4]

Proposed General Plan Update buildout would involve soil disturbance, construction, and operation of developed land uses that could each be subject to unstable soils conditions.

Soil Erosion

Soils are particularly prone to erosion during the grading phase of development, especially during heavy rains. The use of a Storm Water Pollution Prevention Plan (SWPPP), which specifies best management practices for temporary erosion controls, reduces the potential for erosion during construction period activities. Standard erosion control measures would be implemented as part of a SWPPP for proposed projects within the plan area to minimize the risk of erosion or sedimentation during construction. The SWPPP must include an erosion control plan that prescribes measures such as phasing grading, limiting areas of disturbance, designating restricted-entry zones, diverting runoff from disturbed areas, protective measures for sensitive areas, outlet protection, and provisions for revegetation or mulching.

Mandatory compliance with existing regulations, including the preparation and submittal of a SWPPP and a soil engineering evaluation, would reduce impacts to a less than significant level. A comprehensive discussion of erosion and water quality from rain events can be found in Section 5.9, *Hydrology and Water Quality*.

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Expansive Soils

Based on the presence of alluvial materials in the plan area, there is some potential for expansive soils throughout Santa Ana (Morton 2004; USDA 1978). Expansive soils are possible wherever clays and elastic silts may be present, including alluvial soils and weathered granitic and fine-grained sedimentary rocks. The presence of expansive soils represents a hazard to structures and people.

CBC design code has been adopted by the City and requires that structures be designed to mitigate expansive soils. Methods that could be used to reduce the impact of expansive soils include drainage control devices to limit water infiltration near foundations, over-excavation and recompaction of engineered fill method, or support of the foundation with piles. These project design measures, or a combination of them, will reduce the impact of expansive soils to less than significant.

Settlement and Collapse

Settlement and collapse are likely to exist in areas with alluvial soils. Areas of large settlement can damage, or in extreme cases, destroy structures. The presence of compressible soils in the city represents a hazard to structures and people.

CBC design code has been adopted by the City and requires that structures be designed to mitigate compressible soils. Methods that could be used to reduce the impact of compressible soils include in-situ densification, transferring the load to underlying non-compressible layers with piles, and overexcavation of compressible soil and recompaction with engineered fill. These design measures, or a combination of them, would reduce the impact of compressible soils to less than significant.

Subsidence

Subsidence has been historically documented in Santa Ana and is considered a potential hazard (Riel et al. 2018). Historically, subsidence in Santa Ana does not show a pattern of widespread irreversible permanent lowering of the ground surface. The probability of subsidence impacts is generally low in the majority of Santa Ana, with the most susceptible areas along the margins of the Santa Ana River and Santiago Creek. Groundwater storage by Orange County Water District and statutory commitments to sustainable groundwater management practices reduce the potential for future land subsidence, and ongoing surveying of the ground surface by Orange County Water District provides a way to verify that its efforts in preventing subsidence are effective. The statutorily required sustainable groundwater management practices of the Orange County Water District reduce the impact of subsidence to less than significant.

Level of Significance Before Mitigation: With the implementation of RR G-1 and RR G-2; Conservation Policies 2.1, 2.3, and 4.1 through 4.6; Land Use Policies 4.3 and 4.4; ~~Open Space Policy 1.6;~~ Public Services Policies 2.2, 3.4, and 3.8; and Safety Policies 1.6 and 1.7, Impact 5.6-2 will be less than significant.

Impact 5.6-3: Future development in the plan area would require connection to the City's sewer system. [Threshold G-5]

The City of Santa Ana has implemented RR G-3, which does not allow for the installation of septic tanks.

Level of Significance Before Mitigation: With the implementation of RR G-3 and Public Services Policies 3.2 and 3.12, Impact 5.6-3 will be less than significant.

Impact 5.6-4: Future development that would be accommodated by the General Plan Update could impact known and unknown paleontological resources. [Threshold G-6]

Paleontological resources are recognized as nonrenewable and therefore receive protection under the California Public Resources Code and CEQA. Adoption of the General Plan Update in itself will not directly affect paleontological resources. Long-term implementation of the General Plan Update land use plan could allow development (e.g., infill development, redevelopment, and revitalization/restoration), including grading, of known and unknown sensitive areas. Grading and construction activities of undeveloped areas or redevelopment that requires more intensive soil excavation than in the past could potentially disturb paleontological resources. Therefore, future development that would be accommodated by the General Plan Update could potentially unearth previously unrecorded resources. Review and protection of paleontological resources are also afforded by CEQA for individual development projects that would be accommodated by the General Plan Update, subject to discretionary actions that are implemented in accordance with the land use plan of the General Plan Update.

As shown in Section 5.6.1.2, fossil localities have been found in the vicinity of the plan area, although not in the plan area itself. Table 5.6-3 and Figure 5.6-3 show the paleontological sensitivity of the geological units within the plan area.

Level of Significance Before Mitigation: Impact 5.6-4 would be potentially significant before mitigation.

5.6.5 Level of Significance Before Mitigation

Upon implementation of regulatory requirements and standard conditions of approval, some impacts would be less than significant: 5.6-1, 5.6-2, and 5.6-3.

Without mitigation, this impact would be **potentially significant**:

- **Impact 5.6-4** Paleontological resources could be impacted by development resulting from the implementation of the General Plan Update.

5.6.6 Mitigation Measures

Impact 5.6-4

Paleontological Resources

GEO-1 **High Sensitivity.** Projects involving ground disturbances in previously undisturbed areas mapped as having "high" paleontological sensitivity shall be monitored by a qualified paleontological monitor on a full-time basis. Monitoring shall include inspection of exposed sedimentary units during active excavations within sensitive geologic sediments. The monitor shall have authority to temporarily divert activity away from exposed fossils to evaluate the significance of the find and, if the fossils are determined to be significant, professionally and efficiently recover the fossil specimens and collect associated data. The paleontological monitor shall use field data forms to record pertinent location and geologic data, measure stratigraphic sections (if applicable), and collect appropriate sediment samples from any fossil localities.

GEO-2 **Low-to-High Sensitivity**. Prior to issuance of a grading permit for projects involving ground disturbance in previously undisturbed areas mapped with "low-to-high" paleontological sensitivity (see Figure 5.6-3), the project applicant shall consult with a geologist or paleontologist to confirm whether the grading would occur at depths that could encounter highly sensitive sediments for paleontological resources. If confirmed that underlying sediments may have high sensitivity, construction activity shall be monitored by a qualified paleontologist. The paleontologist shall have the authority to halt construction during construction activity as outlined in Mitigation Measure GEO-3.

GEO-3 **All Projects**. In the event of any fossil discovery, regardless of depth or geologic formation, construction work shall halt within a 50-foot radius of the find until its significance can be determined by a qualified paleontologist. Significant fossils shall be recovered, prepared to the point of curation, identified by qualified experts, listed in a database to facilitate analysis, and deposited in a designated paleontological curation facility in accordance with the standards of the Society of Vertebrate Paleontology (2010). The most likely repository is the Natural History Museum of Los Angeles County. The repository shall be identified and a curatorial arrangement shall be signed prior to collection of the fossils.

5.6.7 Level of Significance After Mitigation

Impact 5.6-4

Mitigation Measures GEO-1 through GEO-3 prescribe requirements for monitoring based on the sensitivity of sites for paleontological resources. Under GEO-1, areas that range from high to low sensitivity are required to prepare a Paleontological Resources Monitoring and Mitigation Plan. With adherence to mitigation measures GEO-1 through GEO-3, Impact 5.6-4 would be less than significant.

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