5.5 GEOLOGY AND SOILS

This section of the DEIR evaluates the potential for implementation of the Sierra Madre General Plan Update (General Plan Update) to impact geological and soil resources in the City of Sierra Madre. The analysis in this section is based in part on the following technical report, which is incorporated by reference in this DEIR:

- City of Sierra Madre General Plan Update Technical Background Report, PlaceWorks, September 2012.

5.5.1 Environmental Setting

5.5.1.1 REGULATORY SETTING

State and local laws, regulations, plans, or guidelines that are potentially applicable to the General Plan Update are summarized below.

State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code Sections 2621 et seq.), administered by the California Geologic Survey (CGS), was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The main purpose of the act is to prevent the construction of buildings used for human occupancy on the surface trace of state-designated active faults. The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Special Studies Zone) around the surface traces of active faults and to issue maps of such zones. Local agencies must regulate most development projects within the established regulatory zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings will not be constructed across active faults. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault, and is not allowed within 50 feet of the trace of an active fault.

Seismic Hazard Mapping Act

The Seismic Hazard Mapping Act was adopted by the state in 1990 to protect public safety from the effects of earthquake hazards apart from surface fault rupture, including strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The goal of the act is to minimize loss of life and property by identifying and mitigating seismic hazards. CGS prepares and provides local governments with seismic hazard zone maps that identify areas susceptible to amplified shaking, liquefaction, earthquake-induced landslides, and other ground failures. The seismic hazard zones delineated by the CGS are called "zones of required investigation" because site-specific geological investigations are required for construction projects within these areas.

Natural Hazards Disclosure Act

The Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a Natural Hazard Disclosure Statement when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone.

California Building and Residential Codes

The state regulations protecting human-occupied structures from geoseismic hazards are provided in the most recent (2013) California Building Code (CBC; California Code of Regulations, Title 24, Part 2) and California Residential Code (CRC; California Code of Regulations, Title 24, Part 2.5). Cities and counties were required to enforce the regulations of the CBC and CRC beginning January 1, 2014. The CBC (adopted by reference in Chapter 15.04 [Building Code and Permits] of the City's Municipal Code) and CRC (adopted by reference in Chapter 15.06 [California Residential Code] of the City's Municipal Code) contain provisions to safeguard against major structural failures or loss of life caused by earthquakes or other geologic hazards. For example, the CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground motion with specified probability of occurring at the site.

Additionally, requirements for geotechnical investigations are included in Appendix J Section J104 of the CBC; additional requirements for subdivisions requiring tentative and final maps and for other specified types of structures are contained in California Health and Safety Code Sections 17953 to 17955 and in Section 1802 of the CBC. Testing of samples from subsurface investigations is required, such as from borings or test pits. Studies must be done as needed to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on load-bearing capacity, compressibility, liquefaction, differential settlement, and expansiveness.

Local

City of Sierra Madre Municipal Code

The City's Municipal Code has existing standards and regulations that mitigate potential seismic and geologic safety concerns related to new construction. The following is a description of the provisions of the City's Municipal Code that are applicable to the General Plan Update.

- **Chapter 15.04 (Building Code and Permits).** This chapter adopts by reference the most recent (2013) California Building Code, with certain amendments.

- **Chapter 15.06 (California Residential Code).** This chapter adopts by reference the most recent (2013) California Residential Code, with certain amendments.

- **Chapter 15.48 (Excavations and Grading).** The purpose of this chapter is to safeguard life, limb, property and public welfare by establishing minimum requirements for regulating grading and procedures by which these requirements may be enforced. It outlines the requirement for projects that required a grading permit.

City of Sierra Madre Natural Hazard Mitigation Plan

The City of Sierra Madre Natural Hazard Mitigation Plan was adopted by the Sierra Madre City Council in 2008; local jurisdictions are required to adopt a state-approved Multi-Hazard Mitigation Plan per the federal Disaster Mitigation Act of 2000 (Public Law 106-390).) The Natural Hazard Mitigation Plan was adopted in order to facilitate timely and orderly responses in disaster situations, including earthquakes and landslides. It includes resources and information to assist city residents, public and private sector organizations, and others interested in participating in planning for natural hazards. The Natural Hazard Mitigation Plan provides a list of action items that may assist the city in reducing risk and preventing loss from future natural hazard events (Sierra Madre 2008).

5.5.1.2 GEOLOGIC SETTING

Regional Setting

California is divided into geomorphic provinces, which are distinctive, generally easy-to-recognize natural regions in which the geologic record, types of landforms, pattern of landscape features, and climate are similar. The city is within the boundaries of two geomorphic provinces. The southern urbanized area is within the Peninsular Ranges Geomorphic Province and the northern foothill area is within the Transverse Ranges Geomorphic Province.

The Peninsular Ranges Geomorphic Province is a series of mountain ranges separated by northwest-trending valleys, which characterizes the southwest portion of California. The trend of topography in this province is similar to the Coast Ranges, but the geology is more like the Sierra Nevada, with granitic rock intruding the older metamorphic rocks. Regional faults within the Peninsular Ranges province are oriented southeast to northwest. The Peninsular Ranges extend from lower California to the Mexican border and are bounded on the east by the Colorado Desert, on the north by the Transverse Ranges, on the west by the Pacific Ocean, and on the south by the Mexican peninsula of lower Baja California. The chief Peninsular Ranges are the Santa Ana, San Jacinto, and Santa Rosa. In the north is the low basin that includes Los Angeles.

The Transverse Ranges Geomorphic Province is an east-west trending series of steep mountain ranges and valleys; mountain ranges within this province include the San Gabriel, Verdugo, and Tehatchapi Mountains. The east-west structure of the Transverse Ranges is oblique to the normal northwest trend of coastal California, hence the name "Transverse." The Transverse Ranges are bounded on the east by the San Bernardino Mountains, on the north by the Coast Ranges, on the west by the Pacific Ocean, and on the south by the Peninsular Ranges. The Sierra Madre Fault Zone forms the range's southern boundary. The province also extends offshore to include San Miguel, Santa Rosa, and Santa Cruz islands.

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GEOLOGY AND SOILS

Local Setting

Sierra Madre is on the alluvial plain in the northwestern portion of the San Gabriel Valley. An alluvial plain is a deposit of sediment that gathers over time as it is deposited by a river or stream. The city's topography is characterized by broad, gentle foothill slopes within the southern portions of the City and steep hillsides and ridgeline-canyon terrain in the northern portions adjacent to the San Gabriel Mountains of the Angeles National Forest. The northern portion of the city is in an area where the alluvial plain meets the southern foothills of the San Gabriel Mountains. The majority of Sierra Madre's urban development is located within the gentler sloping foothill areas of the city. Elevations in the City range from a high of 1500 feet to a low of 600 feet. The terrain of the central and southern parts of the city is gently sloping with a consistent south slope of 7.5 percent (Sierra Madre 2008).

Geologic Units

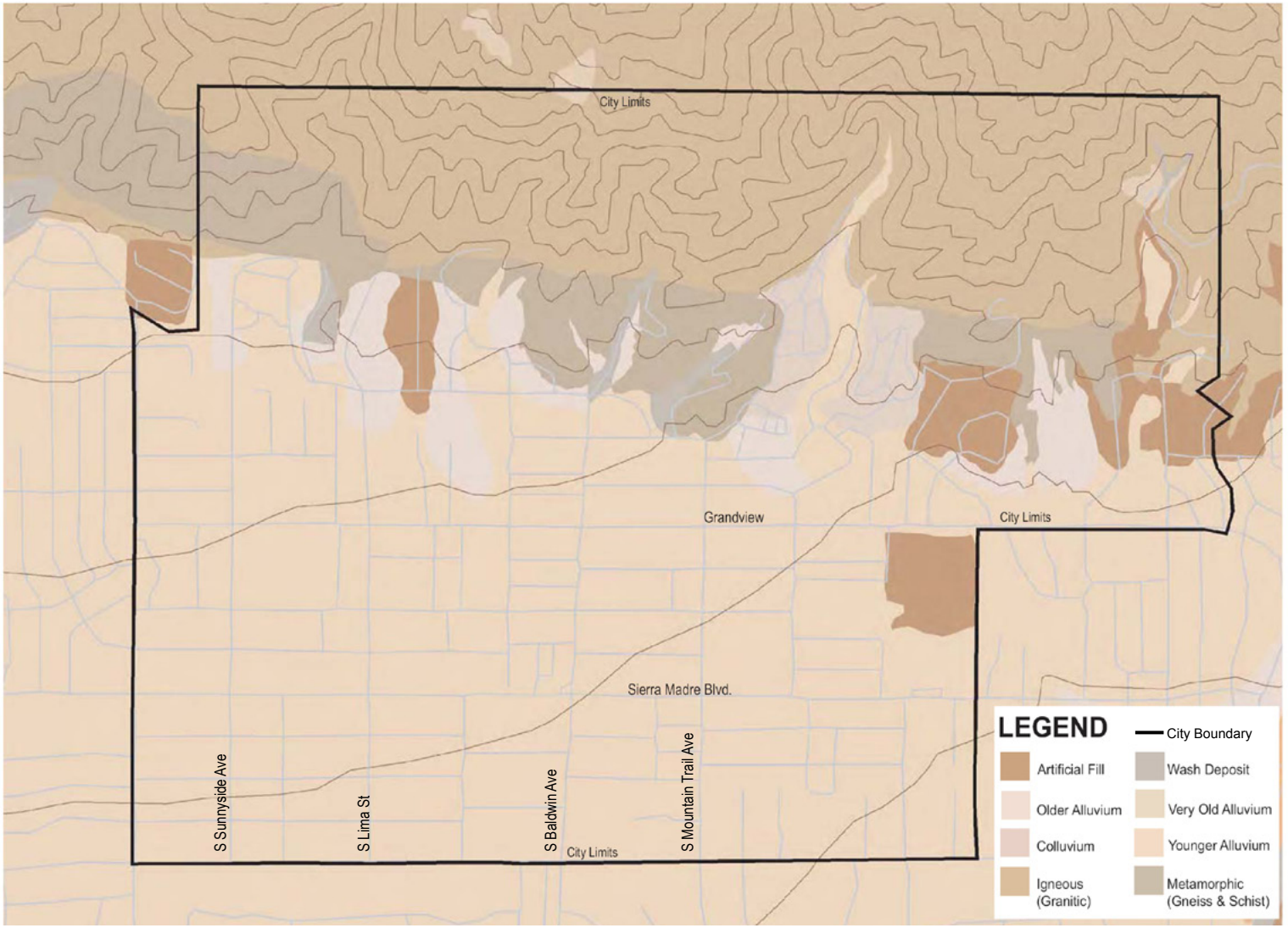
The geologic units within the city are of two distinct types. The southern portion of the city consists of Pleistocene deposits – that is, deposits aged between 12,000 and 1.8 million years. Geologic units mapped in the southern portion of the city include alluvial fan deposits, which are derived from the San Gabriel Mountains to the north. A majority of the developed areas within the city have been built atop these soils. Much of the alluvial sediment in the central and southern sections of Sierra Madre is mapped as Quaternary young alluvial fan deposits (map symbols Qyf and Qyf_1) consisting of gravel, sand, and silt, that are bouldery near mountain fronts (USGS 2005). The hillsides in the northern portion of the city, however, are characterized by Mesozoic plutonic rocks – that is, igneous rocks and associated metamorphic rocks that formed at great depth; the Mesozoic era extends from approximately 250-65 million years ago (CGS 2013). These rocks are typically very hard and exhibit high amounts of fracturing in areas close to active faults. Figure 5.5-1, *Local Geology*, shows the geologic unit and soil types identified within the city's boundaries.

Faulting and Seismic Hazards

Southern California has many earthquakes because it straddles the boundary between the North American and Pacific tectonic plates, and fault rupture often results from their motion. There are many active and potentially active faults within or in the vicinity of the city, including the Sierra Madre Fault, Clamshell-Sawpit Fault, and Raymond Fault (see Figure 5.5-2, *Regional Faults*). The nearest active fault is the Sierra Madre Fault, which passes through the northern part of the city along the base of the San Gabriel Mountains in a west-northwesterly direction. This fault consists of several sub parallel branches found at the base of the mountains and within the one-quarter mile of slope above the mountain base.

Although the Sierra Madre, Clamshell-Sawpit and Raymond Faults are the primary faults that pose a hazard to the city, earthquakes occurring on other regional faults could also cause considerable damage. Other notable faults in the region include the San Andreas, Newport-Inglewood, Palos Verdes, Whittier and Malibu Coast Faults, all of which are considered to be active. An earthquake along any of these faults would represent a hazard in the region, potentially causing many deaths and injuries, along with extensive property damage.

Figure 5.5-1 - Local Geology
5. Environmental Analysis



Source: ESRI, 2011.

5. Environmental Analysis
GEOLOGY AND SOILS

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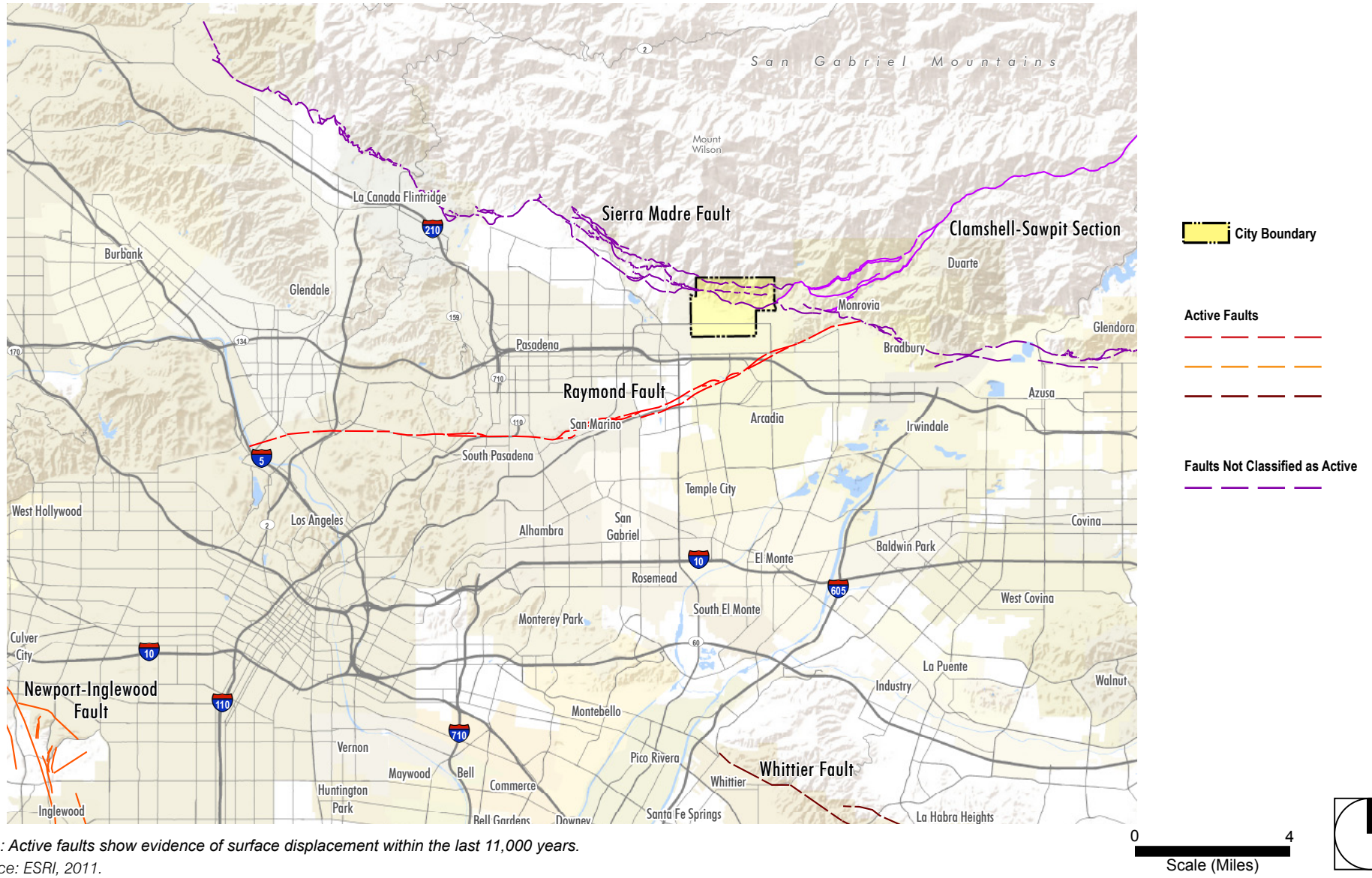
Figure 5.5-2 - Regional Faults
5. Environmental Analysis



Note: Active faults show evidence of surface displacement within the last 11,000 years.
Source: ESRI, 2011.

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GEOLOGY AND SOILS

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No Alquist-Priolo Earthquake Fault Zones are designated in the City; however, the map covering the city showing Alquist-Priolo Earthquake Fault Zones was prepared in 1977, and many known active faults have not yet been designated Alquist-Priolo Earthquake Fault Zones. For example, an active fault in proximity to the City is the Raymond Fault located approximately 1.5 miles south of the city (see Figure 5.5-2, *Regional Faults*). The Raymond Fault is designated an Alquist-Priolo Earthquake Fault Zone by CGS in their Publication of the Preliminary Review Alquist-Priolo Earthquake Fault Zone Map for the Mt. Wilson quadrangle (CGS 2014), which includes Sierra Madre; the map may be issued sometime in the fall of 2015, however, the timing of issuance is uncertain.

Ground Shaking

Earthquakes are caused by the violent and abrupt release of strain built up along faults. When a fault ruptures, energy spreads in the form of seismic waves. Hazards associated with seismic waves include ground rupture, ground shaking, landsliding, flooding, liquefaction, tsunamis, and seiches. Seismic hazards that could affect Sierra Madre include ground rupture and shaking, landslides, and liquefaction. The city has one liquefaction zone, as shown in Figure 5.5-3, *Seismic Hazards*. Of these hazards, ground shaking presents the most significant risk in terms of potential structural damage and loss of life. Intensity of ground shaking and the resultant damages are determined by the magnitude of the earthquake, the distance from the epicenter, and characteristics of surface geology.

Since seismologists started recording and measuring earthquakes, there have been tens of thousands of recorded earthquakes in southern California, most with a magnitude below three. Table 5.5-1 lists the historical earthquake events that have affected southern California, including Sierra Madre, from 1769 to the present.

Table 5.5-1 Southern California Region Earthquakes with a Magnitude 5.0 or Greater

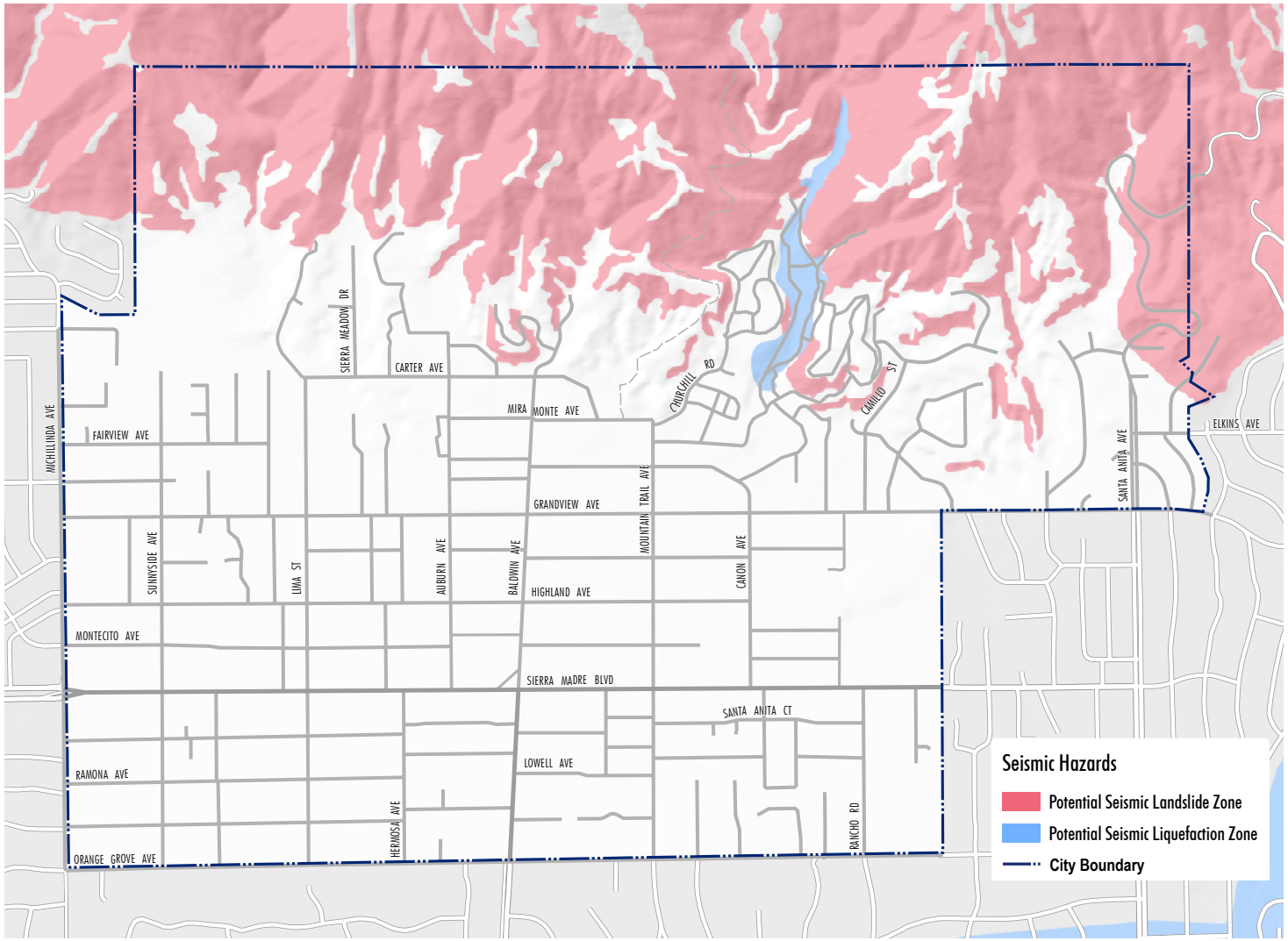
1769 Los Angeles Basin	1937 San Jacinto Fault (Terwilliger Valley)
1800 San Diego Region	1940 Imperial Valley
1812 Wrightwood	1942 Fish Creek
1812 Santa Barbara Channel	1948 Desert Hot Springs
1827 Los Angeles Region	1952 Kern County
1855 Los Angeles Region	1954 W. of Wheeler Ridge
1857 Great Fort Tejon	1954 San Jacinto Fault
1858 San Bernardino Region	1968 Borrego Mountain
1892 San Jacinto or Elsinore Fault	1971 San Fernando/Sylmar
1893 Pico Canyon	1980 White Wash
1894 Lytle Creek Region	1986 North Palm Springs
1894 E. of San Diego	1987 Whittier Narrows
1899 Lytle Creek Region	1987 Elmore Ranch
1899 San Jacinto	1987 Superstition Hills
1899 Hemet	1988 Pasadena
1907 San Bernardino Region	1990 Upland
1910 Glen Ivy Hot Springs	1991 Sierra Madre
1910 Elsinore	1992 Landers
1916 Tejon Pass Region	1992 Joshua Tree
1918 San Jacinto	1992 Big Bear
1923 San Bernardino Region	1994 Northridge
1925 Santa Barbara	1999 Hector Mine
1941 Carpinteria	2003 Paso Robles
1933 Long Beach	2008 Chino Hills

Sources: Sierra Madre 2008; SCEDC 2011

The peak ground acceleration estimated to occur in an earthquake with 10 percent chance of exceedance in 50 years in firm rock conditions in the San Gabriel Mountains (approximately 1.4 miles north of Sierra Madre) ranges between 0.76 and 0.79g, where g is the acceleration of gravity. The estimated peak ground acceleration in the same strength earthquake in alluvial conditions approximately 0.6 miles south of Sierra Madre is 0.70g (CGS 1998).

Ground acceleration of 0.70g to 0.79g correlates with intensity IX on the Modified Mercalli Intensity (MMI) Scale (Wald 1999), a subjective scale of how earthquakes are felt by people and the effects of earthquakes on buildings. The MMI Scale is a 12-point scale where Intensity I earthquakes are generally not felt by people; in Intensity XII earthquakes damage is total, and objects are thrown into the air. In an intensity IX earthquake, damage is considerable in specially designed structures, and well-designed frame structures are thrown out of plumb. Damage is great in substantial buildings, with partial collapse, and buildings are shifted off foundations (USGS 2012).

Figure 5.5-3 - Seismic Hazards
5. Environmental Analysis



Source: ESRI, 2011.

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Liquefaction

Liquefaction refers to loose, saturated sand or silt deposits that behave as a liquid and lose their load-supporting capability when strongly shaken. Loose granular soils and silts that are saturated by relatively shallow groundwater are susceptible to liquefaction. The city has one liquefaction hazard zone, in and near Little Santa Anita Canyon in the northeastern part of the city, as shown in Figure 5.5-3, *Seismic Hazards*.

Landslides

Landslides are another natural disaster risk relevant to the southern foothills of the San Gabriel Mountains that lie within the northern boundary of Sierra Madre, as shown in Figure 5.5-3. Landslides can occur for various reasons. For example, severe flooding can undermine the integrity of the soils in the hillsides, therefore causing instability. Landslides may also occur as the result of brush fires, which weaken the soil by removing vegetation integral to its support structure. Earthquakes can easily start a landslide of already unstable earth mass. Grading activities can also trigger landslides.

Landslides in the city typically occur at elevations of between 1,400 and 2,000 feet, well above the urban area of the city. A common type of landslide experienced in Sierra Madre is known as a mudflow. This type of landslide involves very rapid downslope movement of saturated soil, sub-soil and weathered bedrock. Large mudflows may have enough force to uproot trees and to carry along boulders several feet in diameter. Due to their speed, mudflows can be very destructive, especially along the bottom and the mouths of canyons. Mudflows have occurred in several locations in the northern foothill areas of the city.

Historically, two major landslides have occurred in the northern hillside areas of Sierra Madre. In January 1954, 2,000 residents were urged to evacuate due to major landslide activity in the city's hillside areas and the damage was extensive. In March 1994, a cloudburst below Mount Wilson caused a flash flood and mudslide in Bailey Canyon. The mudslide claimed the lives of two hikers, both Sierra Madre residents (Sierra Madre 2008).

Geologic Hazards

Collapsible Soils

When collapsible soils become saturated, their grains rearrange and lose cohesion, causing rapid, substantial settlement under relatively light loads. Soils prone to collapse are generally young, deposited by flash floods or wind. Increased surface water infiltration, such as from irrigation or a rise in the groundwater table, combined with the weight of a building can cause rapid settlement and cracking of foundations and walls. Certain areas of the city – generally, areas of wash deposits in Santa Anita and Little Santa Anita canyons (see Figure 5.5-1, *Local Geology*) – could be susceptible to collapsible soils.

Ground Subsidence

The major cause of ground subsidence is withdrawal of groundwater. The City of Sierra Madre Natural Hazard Mitigation Plan estimated population at risk and economic losses from several types of natural hazards using the HAZUS software developed by the Federal Emergency Management Agency (FEMA). As

stated in the Natural Hazard Mitigation Plan, no persons in Sierra Madre were estimated to be at risk from land subsidence (Sierra Madre 2008).

Expansive Soils

Expansive soils shrink or swell as the moisture content decreases or increases; the shrinking or swelling can shift, crack, or break structures built on such soils. As stated in the Natural Hazard Mitigation Plan, expansive soils are not a threat to the City (Sierra Madre 2008).

Erosion

Erosion is the movement of rock and soil due to water, wind, and gravity. Soil erosion may be a slow process that continues relatively unnoticed, or it may occur quickly, causing serious loss of topsoil. The rate and magnitude of soil erosion by water is controlled by rainfall intensity and runoff, soil texture and cohesion, slope gradient and length, and vegetation cover. Certain areas of the city, such as the hillside areas, could be susceptible to erosion. Additionally, grading activities temporarily increases the potential for erosion by removing protective vegetation, changing natural drainage patterns, and constructing slopes.

5.5.2 Thresholds of Significance

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

G-1 Expose people or structures to 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 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.

5.5.3 Relevant General Plan Policies and Implementation Program Measures

The following are relevant policies and implementation measures of the Sierra Madre General Plan Update and Implementation Program, respectively, which are designed to reduce potential impacts related to geological and soil hazards from implementation of the General Plan Update.

General Plan Update Policies

Land Use Element

- **Policy L9.4:** Provide incentives to rebuild damaged or demolished structures to pre-existing dimensions but in conformance with the City's building code. Incentives may include fee reductions, permit streamlining and other similar measures.

- **Policy L15.2:** Ensure that development in the hillside areas be located in those areas resulting in the least environmental impact.

- **Policy L15.3:** Require that all access into hillside areas be designed for minimum disturbance to the natural features.

- **Policy L16.1:** Minimize the amount of grading and removal of natural vegetation.

- **Policy L16.2:** Require that home sites be planned, developed and designed to:
  - Eliminate fire hazards.
  - Prevent land instability.
  - Prevent exposure to geological and geotechnical hazards.
  - Provide adequate drainage controls to prevent flooding and landslides.
  - Prevent any other hazard or threat to the public health, safety, and welfare.
  - Use the minimum amount of water possible for landscaping and interior uses.
- **Policy L17.3:** Require that all development preserves, to the maximum extent possible, significant features of the natural topography, including swales, canyons, knolls, ridge lines, and rock outcrops.

- **Policy L17.2:** Require that all development be designed to reflect the contours of the existing land form using techniques such as split pads, detached secondary structures (such as garages), and avoiding the use of excessive cantilevers.

Resource Management Element

- **Policy R1.1:** Maintain and enforce the Hillside Management Zone Ordinance and other ordinances that seek to protect hillside areas.

Hazard Prevention Element

- **Policy Hz10.1:** Require that earthquake survival and efficient post-disaster functioning be a primary concern in the siting, design and construction standards for essential facilities in Sierra Madre.

- **Policy Hz10.2:** Investigate the limitations on the location of new or altered residences and critical, sensitive and high occupancy facilities in areas near active faults, and consider conducting a comprehensive geologic investigation to show where active faults pose a hazard to structures.

- **Policy Hz10.3:** Investigate requiring that proposed new or altered residences and critical, sensitive, and high occupancy facilities located in areas near active faults are not approved unless necessary subsurface fault investigations have first been completed.

- **Policy Hz10.4:** Investigate requiring a thorough subsurface fault investigation be conducted for any proposed habitable structure on private property in close proximity of an active fault zone, and monitor any trenching for public buried water lines in the same area. Assign a City employee the duty of collecting and assessing of data gathered from the above listed efforts with help of a registered geologist.

- **Policy Hz10.5:** Create a central depository of all Sierra Madre geologic information the City obtains through any project approvals process, including any governmental projects.

- **Policy Hz11.1:** Promote public awareness of the need to upgrade seismically hazardous buildings for the protection of health and safety in the city.

- **Policy Hz11.2:** Encourage seismic review of buildings.

- **Policy Hz11.3:** Promote seismic upgrading of older residential and commercial structures with special attention given to historic structures.

- **Policy Hz12.1:** Maintain and update multi-hazard emergency preparedness plan for the City that includes seismic safety.

- **Policy Hz12.2:** Maintain and upgrade the City's disaster response plans at least annually, conduct periodic tests of their practicality and effectiveness, and involve residents and business in the preparation and testing of the plans.

- **Policy Hz12.3:** Prepare and disseminate to residents and businesses information regarding seismic risks affecting the city, measures to protect life and property before and during an earthquake, and emergency procedures to follow after an earthquake.

- **Policy Hz12.4:** Incorporate planning for potential incidents affecting critical, sensitive and high-occupancy facilities into the City's contingency plans for disaster response and recovery.

- **Policy Hz12.5:** Ensure that emergency preparedness is the mutual responsibility of City agencies, city residents and the business community.

- **Policy Hz12.6:** Develop and implement ongoing city-wide programs for disaster preparedness and recovery planning.

- **Policy Hz13.1:** Provide residents and business owners with a continuing awareness and expanding knowledge of the seismic hazards affecting the city.

- **Policy Hz13.2:** Adopt and maintain high standards for seismic performance of buildings, through prompt adoption and careful enforcement of the best available standards for seismic design.

Community Services Element

- **Policy C32.2:** Maintain a disaster plan that provides emergency information on government access television in the event of a disaster.

Implementation Program Measures

Hillside Preservation Implementation Program

- **Measure IM-1:** The City shall continue to enforce the Hillside Zone Ordinance and other ordinances that seek to protect the hillside areas.

Flood/Landslide Implementation Program

- **Measure IM-2:** The City shall amend the Grading, Hillside Management Zone, Low Impact Development, and/or Water Efficient Landscape ordinances to limit the amount of impermeable area that can be constructed as a part of any development project.

Seismic Safety Implementation Program

- **Measure IM-1:** The City shall consider earthquake safety and post-disaster functioning when siting, designing and constructing essential facilities in Sierra Madre.

- **Measure IM-2:** The City will consider engaging the services of a geological consultant to identify areas in the city where active faults pose a hazard to structures, and to assess the need for limitations on the location of new or altered structures near active faults and subsurface investigations prior to project approval.

- **Measure IM-3:** The City shall keep on file any geologic information obtained through project approvals for future reference.

- **Measure IM-4:** The City shall make information available to residents, property owners and emergency responders regarding seismic upgrade of buildings, including historic structures.

- **Measure IM-5:** The City shall collect and undertake a review of buildings that are unreinforced masonry (URM) and soft first-stories.

- **Measure IM-6:** The City shall continue to maintain and update the multi-hazard emergency preparedness plan for the city, and improve emergency coordination between the City's internal departments, outside agencies, and city residents and business.

- **Measure IM-7:** The City shall continue to enforce the Building Code and adopt any updates to seismic requirements in a timely manner.

5.5.4 Environmental Impacts

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

For the impact analysis of all thresholds below, it should be noted that the large infill opportunity site shown in Figure 3-5*, Infill Opportunity Sites*, just north of Carter Avenue, which is associated with the residential subdivision known as Stonegate, is an approved development project and was analyzed under separate environmental documentation in accordance with CEQA. The potential geology and soils impacts resulting from Stonegate were addressed and mitigated for in that environmental documentation. Also, all residential lots within Stonegate are subject the provisions of the City's Municipal Code and the Hillside Management zone regulations (Chapter 17.52) of the City's Municipal Code, which requires that each residential development within Stonegate obtain approval of a hillside development permit.

For the purpose of the following analysis, it is also important to note that, based on the requirements of CEQA, this analysis is based on a comparison to existing land uses and does not address the differences that would result from a comparison with the existing General Plan land use map, from which there is little variation when compared to the proposed General Plan land use map.

Furthermore, it is important to note that while the General Plan Update establishes City-wide policy level guidance, includes a revision to the current land use map (see Figures 3-4, *Current Land Use Map*, and 3-6, *Proposed Land Use Map*), and modifies the development potential of certain parcels in the city (see Figure 3-5, *Infill Opportunity Sites*), it does not contain specific development project proposals. The General Plan Update is a regulatory document that sets forth the framework for future growth and development (e.g., infill development, redevelopment, and revitalization/restoration) in the city and does not directly result in development in and of itself. Before any development can occur in the city, all such development is required to be analyzed for conformance with the City's General Plan, zoning requirements, and other applicable local and state requirements; comply with the requirements of CEQA (e.g., preparation of site-specific environmental documentation in accordance with CEQA); and obtain all necessary approvals, clearances, and permits.

Impact 5.5-1: Implementation of the General Plan Update would not subject people or structures to substantial hazards from surface rupture of a known active fault or strong ground shaking. [Thresholds G-1.i and G-1.ii]

Impact Analysis: Following is a discussion related to potential hazards due to surface rupture of an Alquist-Priolo Earthquake Fault Zone and strong ground shaking.

Alquist-Priolo Earthquake Fault Zone

No Alquist-Priolo Earthquake Fault Zones are designated in the city; however, the map covering the city showing Alquist-Priolo Earthquake Fault Zones was prepared in 1977, and many known active faults have not yet been designated Alquist-Priolo Earthquake Fault Zones. For example, an active fault in proximity to the City is the Raymond Fault (see Figure 5.5-2, *Regional Faults*). The Raymond Fault is designated an Alquist-Priolo Earthquake Fault Zone by CGS in their Publication of the Preliminary Review Alquist-Priolo Earthquake Fault Zone Map for the Mt. Wilson quadrangle, which includes Sierra Madre (CGS 2014); the map may be issued sometime in the fall of 2015, however, the timing is uncertain.

However, the Raymond Fault is approximately 1.5 miles south of the City and therefore, even if it were to be designated by CGS as an Alquist-Priolo Earthquake Fault Zone, it would not pose a threat to future development that would accommodated by the General Plan Update. Due to the distance to this active fault, the potential for surface rupture of a fault onsite is considered very low. Additionally, fault rupture generally occurs within 50 feet of an active fault line and is limited to the immediate area of the fault zone where the fault breaks along the surface (CGS 2007).

Strong Ground Shaking

Future development that would be accommodated by the General Plan would increase the number of residential units, nonresidential structures, residents, and workers in the city. The city is in a seismically active region; strong ground shaking is very likely to occur in the city during the design lifetime of buildings and structures that would be accommodated pursuant to the General Plan Update. There are a number of active and potentially active faults within or in the vicinity of the City, including the Sierra Madre Fault, Clamshell-Sawpit Fault, and Raymond Fault (see Figure 5.5-2, *Regional Faults*). The nearest active fault is the Sierra Madre

Fault, which passes through the northern part of the City along the base of the San Gabriel Mountains in a west-northwesterly direction. This fault consists of several sub parallel branches found at the base of the mountains and within the one-quarter mile of slope above the mountain base. Other notable faults in the region include the San Andreas, Newport-Inglewood, Palos Verdes, Whittier and Malibu Coast Faults, all of which are considered to be active. An earthquake along any of these faults would represent a hazard in the city, potentially causing many deaths and injuries, along with extensive property damage.

However, seismic shaking is a risk throughout southern California, and the city is not at greater risk of seismic activity or impacts than other areas. Additionally, state and local jurisdictions regulate development in California through a variety of tools that reduce hazards from earthquakes and other geologic hazards. For example, the state regulations protecting human-occupied structures from geoseismic hazards are provided in the most recent (2013) CBC (California Code of Regulations, Title 24, Part 2) and CRC (California Code of Regulations, Title 24, Part 2.5). The CBC (adopted by reference in Chapter 15.04 [Building Code and Permits] of the City's Municipal Code) and CRC (adopted by reference in Chapter 15.06 [California Residential Code] of the City's Municipal Code) contain provisions to safeguard against major structural failures or loss of life caused by earthquakes or other geologic hazards. For example, the CBC contains provisions for earthquake safety based on factors including occupancy type, the types of soil and rock onsite, and the strength of ground motion with specified probability of occurring at the site. Additionally, requirements for geotechnical investigations are included in Appendix J Section J104 of the CBC.

The design and construction of the future development that would be accommodated by the General Plan Update would be required to adhere to the provisions of the CBC and CRC, which are imposed on project developments by the City's Planning and Community Preservation Department during the development review and building plan check process. Compliance with the requirements of the CBC and CRC for structural safety during a seismic event would reduce hazards from strong seismic ground shaking.

Additionally, the General Plan Update and Implementation Program include policies and implementation measures, respectively, that would help reduce seismic-related impacts on future developments that would be accommodated under the General Plan Update. Following are some of these policies and implementation measures (refer to Section 5.5.3, *Relevant General Plan Policies and Implementation Program Measures*, for a complete list of applicable policies and implementation measures):

- **Hazard Prevention Element Policy Hz10.1:** Require that earthquake survival and efficient post-disaster functioning be a primary concern in the siting, design and construction standards for essential facilities in Sierra Madre.

- **Hazard Prevention Element Policy Hz10.2:** Investigate the limitations on the location of new or altered residences and critical, sensitive and high occupancy facilities in areas near active faults, and consider conducting a comprehensive geologic investigation to show where active faults pose a hazard to structures.

- **Hazard Prevention Element Policy Hz11.1:** Promote public awareness of the need to upgrade seismically hazardous buildings for the protection of health and safety in the city.

- **Hazard Prevention Element Policy Hz11.3:** Promote seismic upgrading of older residential and commercial structures with special attention given to historic structures.

- **Hazard Prevention Element Policy Hz13.2:** Adopt and maintain high standards for seismic performance of buildings, through prompt adoption and careful enforcement of the best available standards for seismic design.

- **Hazard Prevention Element Policy Hz13.1:** Provide residents and business owners with a continuing awareness and expanding knowledge of the seismic hazards affecting the city.

- **Hazard Prevention Element Policy Hz12.3:** Prepare and disseminate to residents and businesses information regarding seismic risks affecting the city, measures to protect life and property before and during an earthquake, and emergency procedures to follow after an earthquake.

- **Seismic Safety Implementation Measure IM-1:** The City shall consider earthquake safety and post-disaster functioning when siting, designing and constructing essential facilities in Sierra Madre.

- **Seismic Safety Implementation Measure IM-2:** The City will consider engaging the services of a geological consultant to identify areas in the City where active faults pose a hazard to structures, and to assess the need for limitations on the location of new or altered structures near active faults and subsurface investigations prior to project approval.

- **Seismic Safety Implementation Measure IM-4:** The City shall make information available to residents, property owners and emergency responders regarding seismic upgrade of buildings, including historic structures.

- **Seismic Safety Implementation Measure IM-6:** The City shall continue to maintain and update the multi-hazard emergency preparedness plan for the City, and improve emergency coordination between the City's internal departments, outside agencies, and city residents and business.
- **Seismic Safety Implementation Measure IM-7:** The City shall continue to enforce the Building Code and adopt any updates to seismic requirements in a timely manner.

For these reasons, implementation of the General Plan Update would not subject people or structures to substantial hazards from strong ground shaking.

Impact 5.5-2: Implementation of the General Plan Update would not subject people or structures to substantial hazards from liquefaction. [Threshold G-1.iii]

Impact Analysis: As shown in Figure 5.5-3, *Seismic Hazards*, there is one seismic liquefaction zone in the city, in and near Little Santa Anita Canyon in the northeastern part of the city. There are no proposed changes under the General Plan Update in land use designations within the seismic liquefaction zone. The area that falls under this zone is designated RC (Residential Canyon) and H (Hillside) on the current land use map (see Figure 3-4, *Current Land Use Map*), and would remain RC and H under the proposed General Plan land use

map (see Figure 3-6, *Proposed Land Use Map*). Additionally, none of the infill opportunity sites (see Figure 3-5, *Infill Opportunity Sites*), which is where development would be focused under the General Plan Update, occur within the seismic liquefaction zone. For these reasons, implementation of the General Plan Update would not subject people or structures to substantial hazards from liquefaction.

Impact 5.5-3: Implementation of the General Plan would not subject people or structures to substantial hazards from landslides. [Threshold G-1.iv]

Impact Analysis: Soils hazards related to earthquakes, such as liquefaction and induced settlement, are addressed above under Impact 5.5-1.

Much of the northern part of the city is mapped as a zone of required investigation for earthquake-induced landslide by the California Geological Survey, as reflected in Figure 5.5-3, *Seismic Hazards*. Proposed changes in land use designations under the General Plan Update within the seismic landslide zones shown in Figure 5.5-3 can be grouped in two categories:

- Changes from one residential designation to another (see Figures 3-4, *Current Land Use Map*, and 3-6, *Proposed Land Use Map*); none of these changes would increase permitted density. For example, as shown in Figures 3-4 and 3-6, some of the land use designation changes within seismic landslide zones would be from Residential Canyon to Hillside, thereby reducing the permitted density for these areas.

- Changes from a residential designation to nonresidential designations (See Figures 3-4 and 3-6). For example, as shown in Figures 3-4 and 3-6, one of the land use changes would be to convert Residential Canyon to Municipal; most areas designated Municipal are debris basins. Additionally, most of the land use designation changes within seismic landslide zones would be from Hillside to Natural Open Space; the area designated Natural Open Space would remain open space and not subject to development.

Additionally, the provisions of Chapter 17.52 (Hillside Management Zone) of the City's Municipal Code have and would continue to not only protect the natural environment of the city's hillside areas from change, but to protect the hillside areas from hazards such as landslides. For example, as stated in Chapter 17.52, some of the purposes of this chapter include:

- Ensure that development in the hillside areas is located so as to result in the least environmental impact.

- Ensure that all hillside development is designed to fit the existing land form.

- Correlate intensity of development to steepness of terrain to minimize grading, removal of natural vegetation; and to prevent the creation of land instability or fire hazards.

Furthermore, the General Plan Update and Implementation Program include policies and implementation measures, respectively, that would help reduce impacts associated with landslides. Following are some of these policies and implementation measures (refer to Section 5.5.3, *Relevant General Plan Policies and Implementation Program Measures*, for a complete list of applicable policies and implementation measures):

- **Land Use Element Policy L15.2:** Ensure that development in the hillside areas be located in those areas resulting in the least environmental impact.
- **Land Use Element Policy L16.1:** Minimize the amount of grading and removal of natural vegetation.
- **Land Use Element Policy L16.2:** Require that home sites be planned, developed and designed to:
- Prevent land instability.
- Prevent exposure to geological and geotechnical hazards.
- **Land Use Element Policy L17.3:** Require that all development preserves, to the maximum extent possible, significant features of the natural topography, including swales, canyons, knolls, ridge lines, and rock outcrops.
- **Resource Management Element Policy R1.1:** Maintain and enforce the Hillside Management Zone Ordinance and other ordinances that seek to protect hillside areas.
- **Hillside Preservation Implementation Measure IM-1:** The City shall continue to enforce the Hillside Zone Ordinance and other ordinances that seek to protect the hillside areas.
- **Flood/Landslide Implementation Measure IM-2:** The City shall amend the Grading, Hillside Management Zone, Low Impact Development, and/or Water Efficient Landscape ordinances to limit the amount of impermeable area that can be constructed as a part of any development project.
- **Seismic Safety Implementation Measure IM-3:** The City shall keep on file any geologic information obtained through project approvals for future reference.

For these reasons, implementation of the General Plan Update would not subject increased numbers of people or structures to landslide hazards.

Impact 5.5-4: Implementation of the General Plan Update would not result in substantial erosion. [Threshold G-2]

Impact Analysis: Future development that would be accommodated by the General Plan Update could involve excavation, grading, and construction activities that would disturb soil and leave exposed soil on the ground surface. Grading temporarily increases the potential for erosion by removing protective vegetation, changing natural drainage patterns, and constructing slopes. Common means of soil erosion from construction sites include water, wind, and being tracked offsite by vehicles. These activities could result in soil erosion if effective erosion-control measures are not used.

However, future development that would be accommodated by the General Plan Update would be subject to local and state codes and requirements for erosion control and grading during construction. For example, project development is required to comply with standard regulations, including South Coast Air Quality Management District Rules 402 and 403, which would reduce construction erosion impacts. Rule 403 requires that fugitive dust be controlled with best available control measures so that the presence of such dust does not remain visible in the atmosphere beyond the property line of the emissions source. Rule 402 requires dust suppression techniques be implemented to prevent dust and soil erosion from creating a nuisance offsite. For example, as outlined in Table 1 (Best Available Control Measures) of Rule 403, control measures to reduce erosion during grading and construction activities include stabilizing backfilling materials when not actively handling, stabilizing soils during clearing and grubbing activities, and stabilizing soils during and after cut-and-fill activities.

Additionally, the Construction General Permit (CGP) issued by the State Water Resources Control Board (SWRCB), effective July 17, 2012, regulates construction activities to minimize water pollution, including sediment. Future development projects would be subject to National Pollution Discharge Elimination System (NPDES) permitting regulations, including the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for each development project. The development project's construction contractor would be required to prepare and implement an SWPPP and associated best management practices (BMP) in compliance with the CGP during grading and construction. For example, types of BMPs that are incorporated in SWPPPs and would help minimize impacts from soil erosion are outlined in Table 5.5-2.

Table 5.5-2 Construction BMPs

Category	Purpose	Examples
Erosion Controls and Wind Erosion Controls	Cover and/or bind soil surface, to prevent soil particles from being detached and transported by water or wind	Mulch, geotextiles, mats, hydroseeding, earth dikes, swales
Sediment Controls	Filter out soil particles that have been detached and transported in water.	Barriers such as straw bales, sandbags, fiber rolls, and gravel bag berms; desilting basin; cleaning measures such as street sweeping
Tracking Controls	Minimize the tracking of soil offsite by vehicles	Stabilized construction roadways and construction entrances/exits; entrance/outlet tire wash.
Non-Storm Water Management Controls	Prohibit discharge of materials other than stormwater, such as discharges from the cleaning, maintenance, and fueling of vehicles and equipment. Conduct various construction operations, including paving, grinding, and concrete curing and finishing, in ways that minimize non-stormwater discharges and contamination of any such discharges.	BMPs specifying methods for: paving and grinding operations; cleaning, fueling, and maintenance of vehicles and equipment; concrete curing; concrete finishing.
Waste Management and Controls (i.e., good housekeeping practices)	Management of materials and wastes to avoid contamination of stormwater.	Spill prevention and control, stockpile management, and management of solid wastes and hazardous wastes.

Source: CASQA 2003

Adherence to the BMPs in the SWPPP would reduce, prevent, or minimize soil erosion from future project-related grading and construction activities. Additionally, the future project-related grading activities would be required to adhere to the provisions of the City's grading ordinances and CBC. Adherence to these provisions is ensured through the City's development review and building plan check process.

Furthermore, the General Plan Update contains policies designed to minimize impacts related to erosion; these include:

- **Policy L15.2:** Ensure that development in the hillside areas be located in those areas resulting in the least environmental impact.
- **Policy L16.1:** Minimize the amount of grading and removal of natural vegetation.
- **Policy L16.2:** Require that home sites be planned, developed and designed to:
  - Prevent land instability.
  - Prevent exposure to geological and geotechnical hazards.
- **Policy R1.1:** Maintain and enforce the Hillside Management Zone Ordinance and other ordinances that seek to protect hillside areas.

Therefore, soil erosion impacts from future development projects that would be accommodated by the General Plan Update are not anticipated to occur.

Impact 5.5-5: Implementation of the General Plan Update would not expose people or structures to substantial hazards from collapsible soils, ground subsidence, or expansive soils. [Thresholds G-3 (part) and G-4]

Impact Analysis: Hazards related to liquefaction and landslides are addressed above under Impacts 5.5-2 and 5.5-3, respectively.

Following is a discussion of the potential impacts to future development that would be accommodated by the General Plan Update as a result of collapsible soils, ground subsidence, or expansive soils

Collapsible Soils

When collapsible soils become saturated, their grains rearrange and lose cohesion, causing rapid, substantial settlement under relatively light loads. Soils prone to collapse are generally young, deposited by flash floods or wind. Increased surface water infiltration, such as from irrigation or a rise in the groundwater table, combined with the weight of a building can cause rapid settlement and cracking of foundations and walls.

Future development in certain areas of the city (generally, areas of wash deposits in Santa Anita and Little Santa Anita canyons; see Figure 5.5-1, *Local Geology*) under the General Plan Update could be susceptible to collapsible soils. However, individual development projects would be required to adhere to existing building and grading codes. These codes contain provisions for soil preparation to minimize hazards from unstable

soils. For example, Chapter 15.04 (Building Code and Permits) of the City's Municipal Code establishes rules and regulations to control excavation, grading, and earthwork construction (including fills).

Additionally, as standard procedure by the City, grading and soil compaction requires the preparation of site-specific grading plans (per Chapter 15.48 [Excavations and Grading] of the City's Municipal Code), soils and geotechnical reports (which must address potential soil stability hazards), and hydrology studies, which are required to be submitted to and reviewed and approved by the City prior to the commencement of any grading activities. Submittal of these technical plans and studies would ensure that hazards arising from unstable soils would not occur, as they would be prepared in accordance with grading and engineering standards outlined in the most current CBC.

Compliance with existing regulations is not only ensured through the City's development review and building plan check process, but would also ensure that risks arising from unstable soils would not occur.

Ground Subsidence

The major cause of ground subsidence is withdrawal of groundwater. The City of Sierra Madre Natural Hazard Mitigation Plan estimated population at risk and economic losses from several types of natural hazards using the HAZUS software developed by FEMA. As stated in the Natural Hazard Mitigation Plan, no persons in Sierra Madre were estimated to be at risk from land subsidence (Sierra Madre 2008).

Expansive Soils

Expansive soils shrink or swell as the moisture content decreases or increases; the shrinking or swelling can shift, crack, or break structures built on such soils. As stated in the Natural Hazard Mitigation Plan, expansive soils are not a threat to the city (Sierra Madre 2008).

Conclusion

For the reasons outlined above, implementation of the General Plan Update would not expose people or structures to substantial hazards from collapsible soils, ground subsidence, or expansive soils.

5.5.5 Existing Regulations

State

- California Building Code (California Code of Regulations Title 24, Part 2)
- California Residential Code (CRC; California Code of Regulations, Title 24, Part 2.5)

Local

- City of Sierra Madre Municipal Code, Chapters 15.04 (Building Code and Permits), 15.06 (California Residential Code), and 15.48 (Excavations and Grading)

5.5.6 Level of Significance Before Mitigation

Upon compliance with the regulatory requirements and implementation of the General Plan Update policies and Implementation Plan actions, the following impacts would be less than significant: 5.5-1 through 5.5-7.

5.5.7 Mitigation Measures

No mitigation measures are required.

5.5.8 Level of Significance After Mitigation

Impacts would be less than significant and no mitigation measures are required.

5.5.9 References

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