4.6 GEOLOGY AND SOILS

INTRODUCTION

This section of the EIR evaluates the Plan's potential to result in or expose people or property to adverse geologic conditions or hazards. It considers the existing soil conditions, along with the geologic hazards, such as faulting, seismic ground shaking, landslides, and liquefaction. Various federal, State, regional, and local programs and regulations related to anticipated geologic hazards are also discussed in this section.

This section incorporates information from the *Geological and Geotechnical Input For Environmental Impact Report, Proposed Etiwanda Heights Neighborhood and Conservation Plan* (Geotechnical Report), dated March 2019, prepared by Leighton and Associates. This Geotechnical Report is provided in **Appendix G** of this Draft EIR.

ENVIRONMENTAL SETTING

Regulatory Framework

a. Federal

Earthquake Hazards Reduction Act

The US Congress passed the Earthquake Hazards Reduction Act in 1977 to reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards reduction program. To accomplish this goal, the act established the National Earthquake Hazards Reduction Program. This program was substantially amended in November 1990 by the National Earthquake Hazards Reduction Program Act, which refined the description of agency responsibilities, program goals, and objectives.

b. State

Alquist-Priolo Earthquake Fault Zoning Act

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to identify hazards associated with surface fault ruptures and to prevent the construction of buildings on active faults.[1] The State Geologist is required to establish and map zones around the surface traces of active faults, which are then distributed to county and city agencies to be incorporated into their land use planning and construction policies. Proposed development needs to be proven through geologic investigation to not be located across active faults before a city or county can permit the implementation of projects. If an active fault is found, development for human occupancy is prohibited within a 50-foot setback from the identified fault.

1 Alquist-Priolo Earthquake Fault Zoning Act, California Public Resources Code (PRC), sec. 2621.5.

Alquist-Priolo Special Studies Zones are now commonly known as State of California Earthquake Fault Zones.

Seismic Hazards Mapping Act

The purpose of the Seismic Hazards Mapping Act is to protect the public from the effects of non-surface fault rupture earthquake hazards, inducing strong ground shaking, liquefaction, seismically induced landslides, or other ground failure caused by earthquakes. The Seismic Hazards Mapping Act requires delineated maps to be created by the State Geologist to reflect where potential ground shaking, liquefaction, or earthquake-induced landslides may occur.[2] Cities and counties are required to obtain approval for development on non-surface fault rupture hazard zones and mitigate seismic hazards.

California Building Standards Code, California Code of Regulations

The California Building Standards Code (CBC) is administered by the California Building Standards Commission (CBSC).[3] The CBC governs all development within the State of California, as amended and adopted by each local jurisdiction. These regulations include provisions for site work, demolition, and construction, which include excavation and grading, as well as provisions for foundations, retaining walls, and expansive and compressible soils. The CBC provides guidelines for building design to protect occupants from seismic hazards. The most recent version of the code, the 2016 CBC, went into effect on January 1, 2017.[4]

The CBC also requires geological and soil engineering studies to be made for the construction of any school building, or for the reconstruction or alternation or addition to any school building for work which alters structural elements if the site of the project is within the boundaries of any Alquist-Priolo Special Studies Zone.

c. Regional and Local

City of Rancho Cucamonga General Plan

The City's existing General Plan was adopted in 2010. The purpose of the City's adopted Public Health and Safety Element is to describe potential safety hazards and to establish policies to minimize danger to residents, workers, and visitors. Specifically, it identifies potential known hazards, including seismic and geologic hazards. The RCA is located within a fault hazard area (refer to **Figure 4.6-1: Regional Fault Map**), a landslide zone, and in a seismic settlement hazard area for both the RCA and NA (refer to **Figure 4.6-2:**

2 Seismic Hazards Mapping Act, PRC sec. 2690–2699.6.
3 California Building Standards Commission (CBSC), "Welcome to the California Building Standards Commission," accessed February 2018, http://www.bsc.ca.gov/.
4 California Building Standards Code, 24 California Code of Regulations (CCR).

Geotechnical Hazards). In addition, the RCA is in an area that contains slopes greater than 30 percent. The consistency of the Plan with goals and policies related to seismic and geologic hazards is discussed in **Section 4.10: Land Use and Planning**, of this Draft EIR, the following are the applicable polices to the Plan from the City's General Plan:

Policy PS-5.1: Require geological and geotechnical investigations in areas of potential seismic or geologic hazards as part of the environmental and developmental review process for all structures proposed for human occupancy

Policy PS-5.5: During the environmental and developmental review process, promote alternative project designs that incorporate low-intensity land uses in areas determined to have significant seismic or geologic constraints.

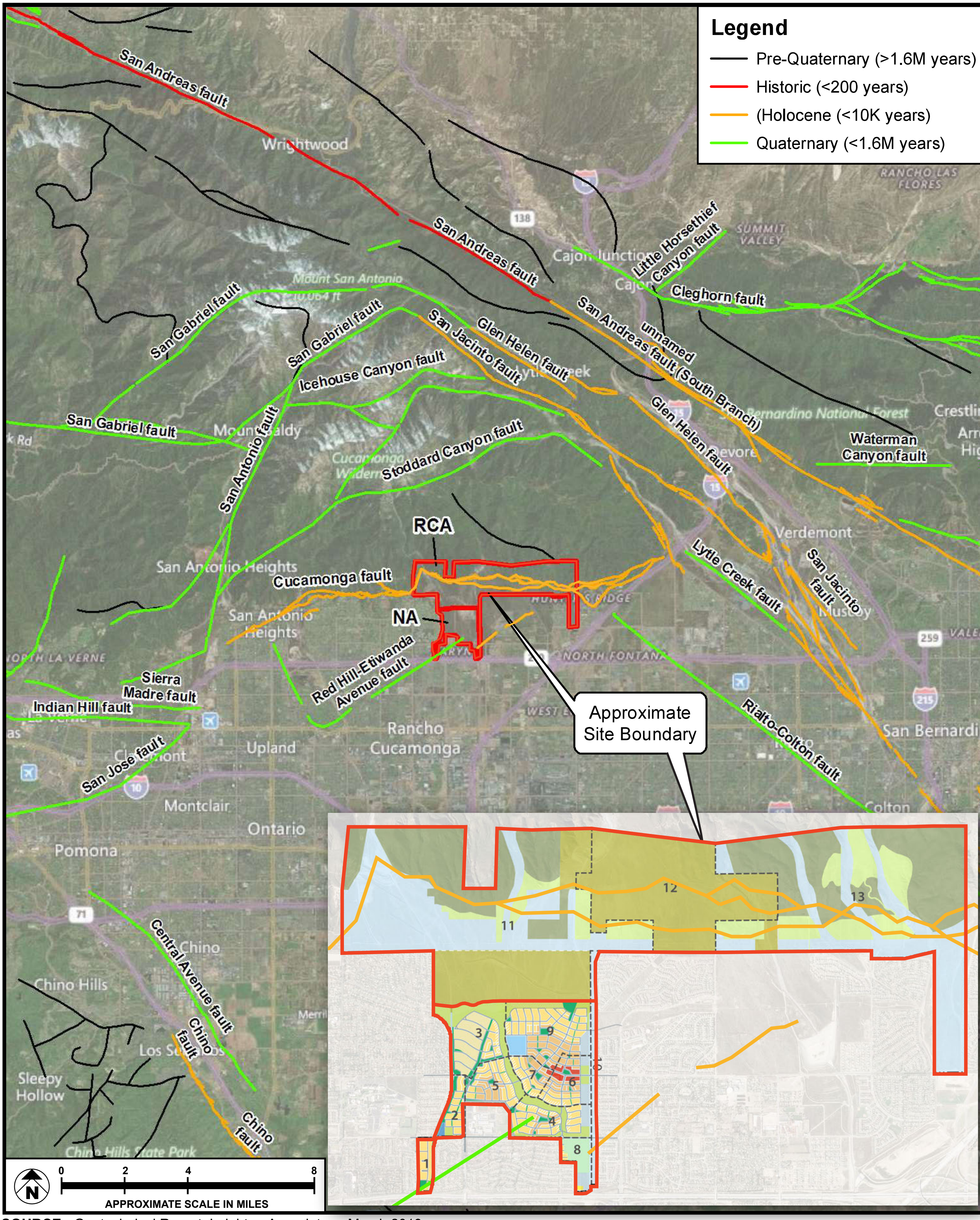
Policy PS-6.1: Continue enforcement of the Hillside Development Guidelines to allow for prudent development and redevelopment of all properties located on slopes greater than 10 percent and continue to preserve as open space properties located on slopes greater than 30 percent.

Rancho Cucamonga Building Regulations

Building regulations in Rancho Cucamonga are specified in Title 15, Buildings and Construction, of the Municipal Code, which adopts the most current CBC. Building construction is governed by the CBC; however, the City has amended and provided exemptions to the CBC that address specific geologic considerations in the City. This title is enforced by the Building and Safety Division; it requires site-specific investigation, and it establishes construction standards and inspection procedures to ensure that development does not pose a threat to public safety.

Rancho Cucamonga Development Code

Section 17.66.060, Odor, Particulate Matter, and Air Contaminant Standards, of the City of Rancho Cucamonga Development Code requires that sources of particulate matter comply with the rules and regulations of the Air Pollution Control District and the State Health and Safety Code. Further, no dust or particulate matter shall be emitted that is detectable by a reasonable person without instruments.



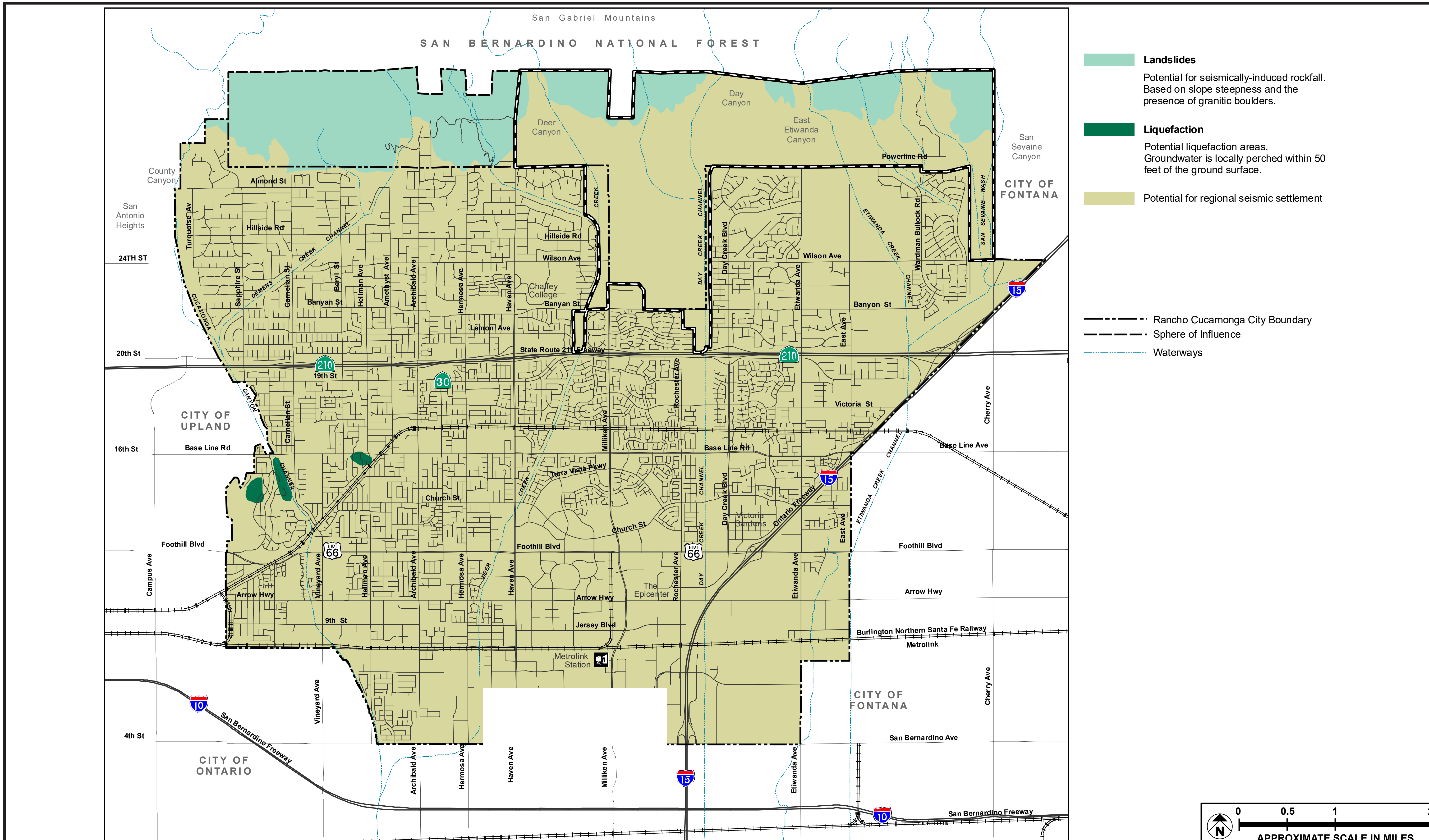
SOURCE: Geotechnical Report, Leighton Associates - March 2019

FIGURE 4.6-1

Meridian Consultants

Regional Fault Map

072-004-18



SOURCE: City of Rancho Cucamonga - 2001; Earth Consultants International - 1999

FIGURE 4.6-2

Meridian Consultants

Geotechnical Hazards

072-004-18

Existing Conditions

The Plan Area is located along the northeastern edge of the City at the base of the San Gabriel Mountains. The Plan Area is located west of Interstate 15 (I-15), north of Interstate 210 (I-210), south of the San Gabriel Mountains, and north of existing residential neighborhoods in the City of Rancho Cucamonga. The western edge and the southeast corner of the Plan are currently located within the City, and the remainder consists of unincorporated area in the County of San Bernardino within the City's Sphere of Influence. The Plan area includes a total of 4,393 acres; the City identifies the northern 3,565 acres of the Plan Area as the RCA and the lower 828 acres as the NA.

The majority of the Plan Area is currently vacant, with occasional dirt access roads and trails throughout. The RCA is largely undeveloped, with the exception of drainage and utility facilities, including the Deer and Day Creek Debris Basins in the northwestern portion of the RCA, electric transmission lines, water supply storage tanks, four private residences, and the Lingyen Mountain Temple. The NA contains the Day Creek Levee, Deer/Day Separation Levee, Day and Deer Creek Flood Control Channels, and a closed sand and gravel quarry. Plant growth currently consists of an assortment of native grasses and brush, with heavy vegetation in the foothill canyon areas.

a. Regional

Geological Setting

Southern California, and more specifically San Bernardino County, is a geologically complex area where the relatively northwest-moving Peninsular Range Province meets the relatively southeast-moving Transverse Ranges Province. The Plan is at the southern edge of the Transverse Ranges geomorphic province, which is characterized by east-west trending mountain ranges including the San Bernardino Mountains and the San Gabriel Mountains. Uplift of these mountains has occurred as a result of compressional forces caused by movements on the San Andreas Fault zone. These compressional forces have also resulted in the east-west trending thrust faults which are found at the base of the southern front of much of the Transverse ranges. The Cucamonga Fault, within the RCA, and the Sierra Madre Fault, to the west, are both examples of such thrust faults. Thrust faults are characterized by shallow dipping fault planes which result from compressional forces "thrusting" one land mass over another.

The San Gabriel Mountains immediately to the north of the RCA are composed of metamorphic "basement" rock, both Precambrian granulitic gneiss and Cretaceous Tonalite. The Plan Area is underlain by granulitic gneiss in the northern portion of the RCA and by quaternary aged alluvial fan deposits in the southern portion of the RCA and within the NA, see **Figure 4.6-3: Regional Geology Map**. The Etiwanda Scarp portion of the Red Hill fault has surface expression where there is a scarp, or break, in the ground surface that marks the faults location. For the Red Hill fault southwest of the Etiwanda Scarp, the location is inferred based on variations in groundwater depth across the fault. It has not been exposed at the surface and does not disrupt the ground surface and thus its location is not well established. Different reports prepared by CGS in review of the Cucamonga and Red Hill faults map the fault in slightly different locations, from 500- to 1000-feet difference, with these variation differences shown as a buffer in **Figure 4.6-3.**

The active San Jacinto Fault trends northwest to southeast located about 2.3 miles to the northeast of the Plan, within the Lytle Creek canyon. The San Andreas Fault is nearly parallel in this area, and is located about 5.2 miles to the northeast of the Plan. These two faults merge within the mountains to the north of the Plan. The San Andreas, San Jacinto, and Cucamonga faults have experienced significant activity in the recent geologic past.

Faulting and Seismicity

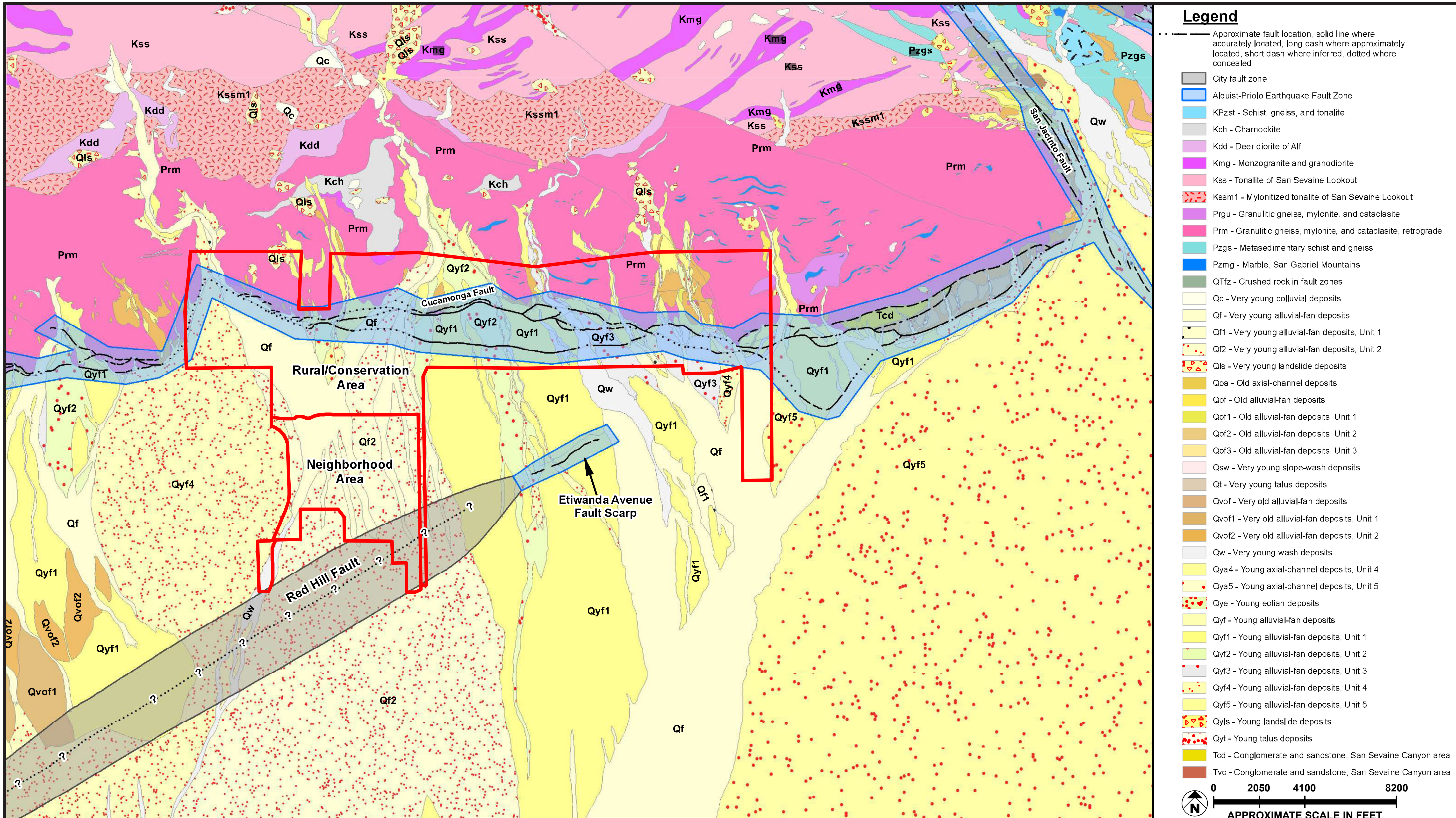
Southern California is a geologically-complex area with numerous fault systems, including strike-slip, oblique, thrust and blind thrust faults. Any specific area of southern California is subject to seismic hazards of varying degree, depending on the proximity and earthquake potential of nearby active faults and the local geologic and topographic conditions. Seismic hazards include primary hazards from surface rupturing of rock and soil materials along active fault traces, and secondary hazards resulting from strong ground shaking.

Nearby Active Faults

Numerous faults have been mapped within this area of Southern California. The most significant and major active fault systems that could produce significant ground shaking at the Plan Area include the Cucamonga, the Red Hill, the San Jacinto, and San Andreas faults, as shown in **Figure 4.6-1**. Characteristics of the known nearby, individual fault systems are discussed below.

Cucamonga Fault Zone

The Cucamonga Fault has been designated as a State of California Earthquake Fault Zone, as shown on the Cucamonga Peak and Devore Quadrangle Earthquake Fault Zones Maps. It is approximately 30 km (19 miles) in length, and is located at the foothills of the San Gabriel Mountains. The fault generally extends from the Lytle Creek area in the east to the Claremont area to the west. The Cucamonga Fault Zone extends through the entire RCA portion of the Plan; however, it does not extend into the NA. The fault offsets recent alluvial deposits along the northern edge of the City. Its presence can be seen on the surface as scarps or disruptions of the alluvial fan surface. The Cucamonga fault is a thrust fault uplifting the San Gabriel Mountains with respect to the valley below. It is estimated to be capable of generating a maximum credible earthquake of moment magnitude (Mw) 6.0 to 7.0.



SOURCE: Geotechnical Report, Leighton Associates - March 2019

FIGURE **4.6-3**

Meridian Consultants

Regional Geology Map

Red Hill Fault Zone

The northeastern portion of the Red Hill Fault, known as the Etiwanda Avenue Fault Scarp, has been designated as a State of California Earthquake Fault Zone as shown on the Cucamonga Peak Quadrangle Earthquake Fault Zones Map. The entire Red Hill Fault Zone is approximately 25 km (16 miles) in length, and is a hyperbola-shaped feature that 'wraps around' Red Hill, a low hill with about 60 m of relief near the western border of the City. Most of the fault is located on the basis of a fairly well-defined subsurface water barrier. The northeastern segment of the Red Hill Fault, mapped near Etiwanda Avenue, has been shown to be active and may be a splay of the Cucamonga fault. The most recent known movement along the Etiwanda Avenue section of this fault zone has occurred within the last few thousand years. A large number of small earthquakes (magnitudes [M] 1 to 3) have historically occurred beneath the City, some which have epicenters on or near the trace of the Red Hill Fault. A maximum credible magnitude of 6.5 is possible on this fault. The inferred Red Hill Fault extends into the southernmost portion of Planning Area 8 of the NA. The City has adopted a more stringent standard than the Alquist-Priolo (AP) Act of 1972 to address this section of the fault and has extended the earthquake fault zone to include this section, see **Figure 4.6-1**.

San Jacinto Fault Zone

The San Jacinto Fault has been designated as a State of California Earthquake Fault Zone. The San Jacinto Fault is located approximately 2.3 miles northeast of the Plan. The San Jacinto Fault is approximately 130 miles in length, and is made up of numerous individual fault strands, the eastern end of which joins with the San Andreas Fault system near Wrightwood. The most recent known surface movement along this fault zone has occurred within the last few hundred years. The Coyote Creek segment of the fault in the vicinity of Borrego Mountain experienced a Mw 6.5 earthquake in April 1968. The San Jacinto Fault, San Bernardino Valley segment is estimated to be capable of generating a maximum credible earthquake of Mw 6.5 to 7.5.

San Andreas Fault

The San Andreas Fault has been designated as a State of California Earthquake Fault. The San Andreas Fault is widely recognized as the longest and most active fault in the State of California. Its activity is known from historic earthquakes, some of which have caused rupture of the ground surface, and from many fault studies that have shown that the San Andreas offsets or displaces recently deposited sediments. The San Andreas Fault has been mapped from Cape Mendocino in Northern California to an area near the Mexican border, a distance of about 750 miles. Recent work indicates that large earthquakes have occurred along the fault at intervals averaging about 140 years, and that during these major earthquakes, the fault breaks along distinct segments. The Southern and San Bernardino segments of the

San Andreas fault are located approximately 5.2 miles northeast of the Plan. These segments of the San Andreas Fault are thought to be capable of producing a maximum credible earthquake of Mw 6.8 to 8.0.

b. Project Site

Faulting and Seismicity

The RCA is located within a State of California designated Earthquake Fault Zone, established per the AP Act, and a County of San Bernardino designated Earthquake Fault, see **Figure 4.6-1**. Based on the act, an active fault is one in which movement occurred along the fault in sometime within the past 11,700 years (within the Holocene). As such, if a fault is present at a site and is observed to offset Holocene aged soils, the fault is deemed active. The California Geological Society (CGS) Special Publication 42 includes the provisions of the Act and an index to maps of Earthquake Fault-Rupture Zones (formerly Alquist-Priolo Special Study Zones). Special Publication 42 also provides state of the practice guidelines for permitting agencies and reviewers, as well as guidance for geoscience consulting practitioners conducting fault studies. The City has extended the earthquake fault zone for the buried uncertain segment of the Red Hill Fault located in the NA, see **Figure 4.6-1**. The NA is not located within a State of California designated Earthquake Fault Zone. However, the City has extended the earthquake fault zone for the buried uncertain segment of the Red Hill Fault located in the southern portion of the NA, and therefore, this area would require geotechnical investigations to determine the presence of a fault trace as part of the environmental process before development would occur. In addition, the City requires geotechnical investigations for all habitable structures proposed within the expanded Cucamonga Fault Zone and in the northeastern and (extended) southwestern segments of the Red Hill Fault Zone (i.e., not just developments with four units or more, as required under the A-P Act). For the central buried segment of Red Hill, the City-designated zone requires geotechnical investigations for essential and critical facilities (i.e., fire stations, hospitals, emergency operations centers, schools, shelters, communication centers, and other facilities that are needed during an emergency) and the strengthening of foundations of essential and critical facilities in this zone.

Strong ground shaking can be expected at the Plan Area during moderate to severe earthquakes in this general region. This is common to virtually all of Southern California. Intensity of ground shaking at a given location depends primarily upon earthquake magnitude, site distance from the source, and site response (soil type) characteristics.

Slope Stability

As stated above, the RCA is within a moderate to high potential landslide susceptibility zone as depicted on the San Bernardino County, General Plan, Geologic Hazard Overlay. The presence of relatively steep topographic relief across this area of the Plan project creates a moderate to high potential for both static and dynamic bedrock slope instability.

Earth Units

The earth units in the Plan Area consists of surficial deposits, including artificial fill, alluvial fan deposits, and landslide deposits, overlaying granulitic gneiss bedrock. The surficial units generally are composed of well graded silty sands and gravels with cobbles and boulders. Granulitic gneiss bedrock is exposed in outcrops across the RCA portion of the Plan.

Artificial Fill

The artificial fill observed within both the RCA and NA was generally seen as localized accumulations associated with unimproved dirt roads and locally infilled canyons and drainages at road crossings. The fill material in both areas is generally composed of sandy silt, and silty fine to coarse grained sand with cobbles and boulders. The inactive quarry within the NA is anticipated to contain significant quantities of artificial fill associated with past quarry and restoration activities.

Landslide Deposits

Young landslide deposits, defined by USGS as well preserved within the late Holocene that may or may not be active, have been mapped in the northern limits of the Plan, entirely within the RCA. The deposits consist of chaotically mixed soil and rubble and (or) displaced bedrock blocks, most of which are debris slides and rock slumps or earth slumps. These landslides may or may not be active.

Alluvial Fan Deposits

Streams from the San Gabriel Mountains to the north carried alluvial deposits down into the valley, with coalescing deposits consisting of coarse gravels to fine-grained sands deposited over the course of the last 10,000 years or greater. The alluvial deposits are thin within the northern portions of the RCA, and as thick as 500 to 1,000 feet at the southern edges of the RCA and within the NA. The alluvial fan deposits within the RCA and NA typically consist of well graded silty sands and gravels with cobbles and boulders. Older alluvial fan deposits are described as moderately porous, well-consolidated, highly oxidized, sandy clay with gravel and abundant decomposed subangular cobbles and local decomposed boulders of granulitic bedrock.

Granulitic Gneiss Bedrock

Granulitic Gneiss metamorphic bedrock is mapped in the mountainous northern portion of the RCA. The bedrock is described as weathered, highly sheared and contorted cataclastic gneiss. Localized concentrations of quartzite and mica-rich zones were also observed, as are localized outcrops of marble.

The bedrock can be hard and dense and difficult to excavate in fresh exposures. However, the near surface of the unit is weathered and fractured and, in some cases, highly fractured along faults and shears.

Groundwater

Based on review of the Plan Area, groundwater is expected to be on the order of 300 to 400 feet below the ground surface in the general site vicinity. Historical high groundwater has been found to be on the order of 300 feet below the ground surface. The granitic bedrock is not generally considered water bearing. Groundwater is not generally expected to be a constraint to development of the site, since groundwater would not be a source of water in the NA. Furthermore, history of the Plan Area indicates that during 1960, groundwater was estimated to be approximately 400 to 500 feet deep below the ground surface in the RCA, south of the Cucamonga Fault, reducing to approximately 300 feet in the NA. In recent decades, groundwater depths are not anticipated to be shallower than 1960 levels. Historic groundwater data is sparse for the portion of the RCA that is north of the Cucamonga Fault

Soils

Compressible and Collapsible Soils

Soil compressibility refers to a soil's potential for settlement when subjected to increased loads, such as from a fill surcharge or structural loads. Based on investigation of the both the RCA and NA, the upper 5 feet of the alluvial soils onsite are generally considered to be slightly compressible. Uncontrolled artificial fill onsite is considered compressible throughout the entire depth. In addition, as shown in **Figure 4.6-2**, the Plan Area is located in a potential for regional seismic settlement area.

Collapse potential refers to the potential settlement of the soil under existing stresses (loads) upon being wetted. Based on the type of soils observed, the potential for significant collapse is considered slight to moderate.

Expansive Soils

Expansive soils contain significant amounts of clay particles that swell considerably when wetted and shrink when dried. Foundations constructed on these soils are subjected to large uplifting forces caused by the swelling. Without proper measures taken, heaving and cracking of both building foundations and slabs-on-grade could result. The alluvial soils across most of the project include sand gravel, cobbles and boulders that generally have a very low expansion potential. However, weathered bedrock and clayey soils may be present within the northern portion of the RCA. Based on these soil types, the soils within the RCA are expected to exhibit an Expansion Index (EI) in the very low to medium range (EI of less than 90), and very low (EI of less than 21) within the NA.

Corrosive Soils

Water-soluble sulfates in soil can react adversely with concrete. However, concrete in contact with soil containing sulfate concentrations of less than 0.10 percent are considered to have negligible sulfate exposure based on American Concrete Institute (ACI) provisions, adopted by the 2016 CBC. Soil corrosivity to ferrous metals can be estimated by the soil's potential of hydrogen (pH) level, electrical resistivity, and chloride content. In general, soil having a minimum resistivity less than 2,000 ohm-cm is considered corrosive. Soil with a chloride content of 500 parts per million or more is considered corrosive to ferrous metals. Soil corrosivity is not a visually discernable characteristic. The soil and bedrock units within the Plan Area may be detrimental to concrete and corrosive to metals.

Rippability and Oversized Rock

The granulitic gneiss bedrock is expected to be weathered and soft in the near surface, but dense and hard in fresh exposures. In deeper excavations it is likely that the bedrock will be difficult to rip with heavy equipment. The excavation characteristics of bedrock and the need for blasting depends on many factors, including the density of the rock, the amount and orientation of fractures, the size and quality of the equipment being used and the skill of the operators. Heavy ripping and/or blasting in bedrock areas may be required for development of the hillside areas of the RCA underlain by bedrock depending on the project design and conditions encountered. The alluvial soil within the Plan includes cobbles and boulders up to several feet in dimension. The 2016 CBC requires that no oversize rock be placed within 10 feet of the surface of a structural fill and/or building pad.

If there are areas of insufficient deep fill, size reduction processing or off-site disposal may be required. Other uses of resistant rock may include onsite riprap or crushing/processing for aggregate base materials. Specific recommendations for placing oversized material should be provided as part of geotechnical studies for development projects within the project area.

ENVIRONMENTAL IMPACTS

Methodology

The information within this section contains information from Geotechnical Report that was conducted for the Plan (refer to **Appendix G**). The analysis of potential impacts to geologic and soil hazards that would be associated with the Plan included the following elements:

- Available published reports and geologic maps were reviewed, and the data analyzed with respect to the Plan. The literature search included review and analysis of aerial photographs from flights between 1955 and 1986 obtained from the Leighton and Associates in-house library. In addition, aerial photographs from historicaerials.com were reviewed which included flights between 1938 and 2012;

- Review of geologic and geotechnical reports previously prepared for portions of the Plan Area and adjacent sites.
- Visits to the Plan Area to observe existing conditions and general distribution of earth units.
- Preparation of this report addressing the geologic, geotechnical engineering and seismic aspects of the Plan Area. The various geologic and geotechnical aspects of the Plan Area were evaluated, and where appropriate, potential mitigation measures were provided.

Thresholds of Significance

To assist in determining whether the Plan would have a significant effect on the environment, the City finds the Plan may be deemed to have a significant impact related to geology and soils if it would:

Threshold GEO-1: **Directly or indirectly cause potential substantial adverse effects involving 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.**

Threshold GEO-2: **Expose people or structures to potential substantial adverse effects involving strong seismic ground shaking.**

Threshold GEO-3: **Expose people or structures to potential substantial adverse effects involving seismic-related ground failure, including liquefaction.**

Threshold GEO-4: **Expose people or structures to potential substantial adverse effects involving landslides.**

Threshold GEO-5: **Result in substantial soil erosion or the loss of topsoil.**

Threshold GEO-6: **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.**

Threshold GEO-7: **Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.**

Threshold GEO-8: **Have soils incapable of adequately supporting use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.**

Threshold GEO-9: Directly or indirectly a unique paleontological resource or site or unique geological feature.

Project Impact Analysis

Threshold GEO-1: Directly or indirectly cause potential substantial adverse effects involving 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.

Rural/Conservation Area

Earthquake Fault Zones established by the State of California along the Cucamonga Fault traverse portions of the RCA (see **Figure 4.6-1**). Previous fault investigations of the Cucamonga Fault have observed onsite faulting and concluded that that fault was active with movement in the Holocene. Therefore, fault-induced ground rupture within the RCA area is possible. Current code, i.e PRC Division 2, Chapter 7.5, Section 2621.5, prohibits constructing structures for human occupancy across the trace of active faults. In order to comply with code, project-level fault studies providing measures for fault-rupture mitigation will need to be conducted for development of structures planned within State established Earthquake Fault Zones; this includes State-established zones for the Cucamonga fault in the RCA. It should also be noted that there are no plans for development of any structures within this portion of the RCA based upon the minimal amount of development as part of the Plan. As such, with regulatory compliance, fault-induced ground rupture impacts would not exacerbate existing conditions within the RCA is less than significant.

Neighborhood Area

Earthquake Fault Zones established by the City along the Red Hill Fault traverse the southernmost portion of NA, including Planning Areas 1, 4, and 8 (see **Figure 4.6-1**). The Etiwanda Scarp portion of the fault has surface expression shown in **Figure 4.6-3.** For this portion of the fault there is a scarp or break in the ground surface that marks the faults location. However, for the Red Hill fault southwest of the Etiwanda Scarp, the location is inferred based on variations in groundwater depth across the fault. It has not been exposed at the surface and does not disrupt the ground surface and thus its location is not well established. Therefore, significant and frequent impacts of faulty activity is not common within the Plan Area.

However, due to the potential of fault-induced ground rupture within the NA area is possible. Similar to the RCA, current code prohibits constructing structures for human occupancy across the trace of active faults. In order to comply with code, project-level fault studies providing measures for fault-rupture mitigation will need to be conducted for development of structures planned within City established Earthquake Fault Zones. However, the Plan would not have any building structures within the active portion associated with the Etiwanda Scarp portion of the fault. As such, with regulatory compliance, fault-induced ground rupture impacts would not exacerbate existing conditions within the NA. Therefore, the impacts would be less than significant.

Threshold GEO-2: Expose people or structures to potential substantial adverse effects involving strong seismic ground shaking.

Rural/Conservation Area

The intensity of ground shaking at a given location depends on several factors, but primarily on the earthquake magnitude, the distance from the hypocenter to the site of interest, and the response characteristics of the soil and/or bedrock units underlying the site. The RCA includes and is surrounded by multiple faults that can produce severe seismic ground shaking due to their locations and potential magnitudes. In the RCA, the hazard posed by seismic shaking is considered high, due to the proximity of known active faults. However, exposure to future ground shaking within the RCA is no greater than at many other sites in the region. In general, there is no realistic way in which the hazard of seismic shaking can be totally avoided. While it is not considered feasible to make structures totally resistant to seismic shaking, the existing code specifies that they be designed to not collapse, with specific levels of service as dictated by the CBC. The effects of seismic shaking on structures can be reduced through conformance with the CBC, which requires a project-level geotechnical investigation to provide seismic design parameters. Note that only the very low-density development would be allowed in the RCA, which could be further reduced through transfer of development rights, keeps the more intense development farther away from the fault areas. This will promote safety in the event of a large earthquake, with the purpose of reducing potential damage to code-acceptable levels. With regulatory compliance, seismic ground shaking impacts would not exacerbate existing conditions within the RCA, and therefore would be less than significant.

Neighborhood Area

Similar to the RCA, the NA includes and is surrounded by multiple faults that can produce severe seismic ground shaking due to their locations and potential magnitudes. However, exposure to future ground shaking within the NA is no greater than at many other sites in the region. As it is not considered feasible to make structures totally resistant to seismic shaking, the existing code specifies that they be designed to not collapse, with specific levels of service as dictated by the CBC. The effects of seismic shaking on structures can be reduced through conformance with the CBC, which requires a project-level geotechnical investigation to provide seismic design parameters. This will promote safety in the event of a large earthquake, with the purpose of reducing potential damage to code-acceptable levels. With regulatory compliance, seismic ground shaking impacts would not exacerbate existing conditions within the NA, and therefore would be less than significant.

Threshold GEO-3: Expose people or structures to potential substantial adverse effects involving seismic-related ground failure, including liquefaction.

Rural/Conservation Area

Liquefaction occurs when loose, cohesionless, water-saturated soils (generally fine-grained sand and silt) are subjected to strong seismic ground motion of significant duration. These soils temporarily behave similar to liquids, losing bearing strength. Structures built on these soils may tilt or settle when the soils liquefy. Liquefaction more often occurs in earthquake-prone areas underlain by young sandy alluvium where the groundwater table is less than 50 feet below the ground surface. According to San Bernardino County, and as shown in **Figure 4.6-2**, the RCA has not been identified as being in an area potentially susceptible to liquefaction. The historically highest groundwater has been estimated to be on the order of 300 feet below ground surface. Thus, the potential for liquefaction in the RCA is considered less than significant.

Neighborhood Area

The NA has also not been identified as being in an area potentially susceptible to liquefaction, as shown in **Figure 4.6-2**. The historically highest groundwater has been estimated to be on the order of 300 feet below ground surface. The proposed development within the NA would be subject to adherence to the minimum standards and seismic safety requirements contained within the current edition of the CBC. The proposed facilities would be subject to adherence to the minimum standards and seismic safety requirements for the design of the proposed buildings and structures associated with the Plan. Thus, the potential for liquefaction in the NA is considered less than significant.

Threshold GEO-4: Expose people or structures to potential substantial adverse effects involving landslides.

Rural/Conservation Area

The northern portion of the RCA is within a moderate to high potential landslide susceptibility zone as depicted on the San Bernardino County General Plan, Geologic Hazard Map. The presence of relatively high topographic relief across the RCA raises the potential hazards from both static and dynamic bedrock slope instability to be moderate to high. Any development in the RCA that is within an area with potential landslide hazard would need to be specifically evaluated during geotechnical investigations for individual projects. This is applicable to any areas with relatively steep topography, which includes the northern portion of the RCA, notably in any potential area where there is identified for potential slope instability. As such, the potential for seismically induced landslides onsite is considered potentially significant**.** However, with incorporation of **Mitigation Measure (MM) GEO-1** for any potential remedial recommendations to limit slope stability, impacts would not exacerbate existing conditions and therefore be reduced to a less than significant level.

Neighborhood Area

The risks associated with landslides occur when buildings or structures are placed on slopes. The NA is relatively flat and contains minimal rises or changes in elevation. No major slopes or bluffs are on or adjacent to the NA. As such, the NA would likely not be subject to seismically induced landslides. As such, landslide impacts would be less than significant.

Threshold GEO-5: Result in substantial soil erosion or the loss of topsoil.

Rural/Conservation Area

Compressible Soils

When a load is placed, such as from fill soil or a building, the underlying soil layers undergo a certain amount of compression. This compression is due to the deformation of the soil particles, the relocation of soil, and the expulsion of water or air from the void spaces between the grains. As a result, effected soils become less able to absorb water, and erosion or settlement can occur. Some of this settlement occurs immediately after a load is applied, while some of the settlement occurs over a period after placement of the load. For engineering applications, it is important to estimate the total amount of settlement that will occur upon placement of a given load, and the rate of compression (consolidation).

Based on field investigation, the upper portion of the surficial soils within the RCA is expected to be slightly to moderately compressible. Organic material and uncompacted fills are also compressible, and are unsuitable for foundation support. Therefore, the impact posed by compressible soils is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-2** for potential removal and re-compaction of the near surface soils, impacts would not exacerbate existing conditions and therefore be reduced to a less than significant level.

Erosion

The native soils within the RCA, as well as fill slopes constructed with native soils, will have a moderate susceptibility to erosion. These materials will be particularly prone to erosion during site development, especially during heavy rains. Therefore, the impact of erosion within the RCA is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-3** by reducing appropriate paving of exposed ground surfaces, landscaping, providing terraces on slopes, placing berms or V-ditches at the tops of slopes, and installation of adequate storm drain systems, impacts would not exacerbate existing conditions and therefore be reduced to a less than significant level.

Rippability and Oversized Rock

The RCA bedrock materials are generally anticipated to be rippable to depths of 5 to 10 feet below ground surface. However, heavy ripping and or blasting may be required if deep cuts in bedrock are required by future development plans. Significant amounts of oversized materials (larger than 12 inches in dimension and ranging to several feet in dimension) are present within the alluvial soil. Such materials are generally not suitable immediately beneath planned structures and may require special handling and placement or disposal offsite during grading. Therefore, rippability and oversized rock disposal impacts are considered to be a potentially significant. However, with incorporation of Mitigation Measure **MM GEO-4** by adjusting potential grades so as to not encounter the non-rippable rock, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Neighborhood Area

Compressible Soils

Similar to the RCA, the NA has the upper portion of the surficial soils onsite to be slightly to moderately compressible. In addition, within the NA there are existing undocumented artificial fills of the inactive quarry are considered compressible and unsuitable for support of structures. Further, if deep fills are to be placed to backfill the quarry, these fills may be subject to significant settlement for a period of time. Therefore, the impact posed by compressible soils is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-2** for potential removal and re-compaction of the near surface soils, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Erosion

Similar to the RCA, the native soils as well as fill slopes constructed with native soils, will have a moderate susceptibility to erosion within the NA. These materials will be particularly prone to erosion during site development, especially during heavy rains. Therefore, the impact of erosion within the NA is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-3** by reducing appropriate paving of exposed ground surfaces, landscaping, providing terraces on slopes, placing berms or V-ditches at the tops of slopes, and installation of adequate storm drain systems, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Rippability and Oversized Rock

Similar to the RCA, the NA bedrock materials are generally anticipated to be rippable to depths of 5 to 10 feet below ground surface. However, heavy ripping and or blasting may be required if deep cuts in bedrock are incorporated into development plans. Significant amounts of oversized materials (larger than 12 inches in dimension and ranging to several feet in dimension) are present within the alluvial soil. Such materials are generally not suitable immediately beneath planned structures and may require special handling and placement or disposal offsite during grading. Therefore, rippability and oversized rock disposal impacts are considered to be a potentially significant. However, with incorporation of Mitigation Measure **MM GEO-4** by adjusting potential grades so as to not encounter the non-rippable rock, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Threshold GEO-6: **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.**

Rural/Conservation Area

Corrosive Soils

Corrosive soils contain constituents or physical characteristics that react with concrete (water-soluble sulfates) or ferrous metals (such as chlorides, low pH levels, and low electrical resistivity). Based on investigation within the RCA, the on-site soils are expected to have soluble sulfate contents in the negligible range. However, the on-site soils are expected to be mildly to moderately corrosive to ferrous metal. Consequently, the hazard to structures and underground improvements from corrosive soil is expected to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-5** for testing prior to construction of the proposed improvements, impacts would not exacerbate existing conditions and therefore, would be reduced to a less than significant level.

Lateral Spreading

Lateral spreading is a phenomenon where large blocks of intact, non-liquefied soil move downslope on a liquefied substrate of relatively large aerial extent. The mass moves toward an unconfined area, such as a descending slope or stream-cut bluff, and is known to move on slope gradients as gentle as 1 degree. Lateral spreading only occurs in areas subject to liquefaction. As the project is not considered susceptible to liquefaction, the potential for lateral spreading within the RCA is considered less than significant.

Regional Subsidence

Regional ground subsidence generally occurs due to rapid and intensive removal of subterranean fluids, typically water or oil. It is generally attributed to the consolidation of sediments as the fluid in the sediment is removed. The total load of the soils in partially saturated or saturated deposits is born by their granular structure and the fluid. When the fluid is removed, the load is born by the sediment alone and it settles. No reports of regional subsidence have been reported in the RCA vicinity, and lack of intense removal of significant quantities of water or oil extraction in the area makes the potential for ground subsidence very low and less than a significant impact.

Induced Settlement

Strong ground shaking can cause settlement by allowing soil particles to become more tightly packed, thereby reducing pore space. Unconsolidated, loosely packed granular alluvial deposits are especially susceptible to this phenomenon. Poorly compacted artificial fills may also experience seismically induced settlement. The alluvial fan deposits across the majority of the RCA are not typically prone to significant seismic settlement, however unconsolidated native soils and artificial fill prone to seismic settlement may be present locally. The alluvium was deposited in a high-energy environment, and is relatively dense and high on the alluvial fan. This means that only a very minor amount of seismic settlement would be present. It should be clarified that the alluvium is not considered low density from a geotechnical engineering standpoint, but instead is relatively dense, in terms of alluvium in general, and was deposited in a high-energy environment, relatively high on the alluvial fan. The potential for seismically induced settlement within alluvium is anticipated to be low (typically negligible) throughout the entire RCA, due to the relatively dense nature of the alluvium. The Municipal Code requires that individual projects evaluate the potential for seismic settlement. As the RCA is located in a site of potential seismic settlement, as shown in **Figure 4.6-2**, the potential for seismically induced settlement is considered potentially significant. However, with incorporation of Mitigation Measure **MM GEO-6** by applying correct implementation of remedial grading and design recommendations, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Stability of Existing Slopes

The northern portion of the RCA has natural steep slopes and mapped landslides. While the bedrock is typically dense, steep slopes can fail along planes of weakness, such as joints or foliation, or where the rock is highly fractured and broken. The RCA also has areas that contain precariously balanced rocks that could potentially fall and/or be dislodged and roll downhill. The City’s Development Code, Article III, Chapter 17.30 (Hillside Residential) indicates that areas with slopes equal to or steeper than 8 percent are considered a “hillside”, and alternative grading and structural design techniques are required. The Code indicates that, “Hillside Development Review is required for any subdivision or development within the Hillside Residential District.” Therefore, project-level geotechnical investigations specifically addressing slope stability and providing requisite mitigation measures are required by the City. Future site-specific geotechnical investigations in areas of planned development are required to be conducted in order to evaluate the potential for slope instability. As such, with regulatory compliance, the risk of impact of natural slope stability is less than significant.

<u>Stability of Proposed Slopes</u>

Design slopes cut into the native soil can be prone to instability, depending on the nature of the earth material underlying the slope. Design fill slopes may also be prone to instability if poorly constructed or constructed of unsuitable earth materials. Consequently, the hazard posed by unstable manufactured slopes is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-7,** in which slopes would be constructed in accordance with the recommendations of the geotechnical engineer, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

<u>Stability of Temporary Slopes</u>

Slope or sidewall failure in temporary excavations for underground utilities or other structures could occur in unconsolidated soils. The risk of failure in temporary slopes is higher because they are generally cut at a much steeper gradient versus permanent manufactured slopes. Consequently, the hazard from temporary slopes is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-8,** in which specific recommended measures for excavation are in place to reduce the potential for temporary slope failure, impacts would not exacerbate existing conditions and therefore be reduced to a less than significant level.

Neighborhood Area

<u>Corrosive Soils</u>

Similar to the RCA, the NA soils are expected to have soluble sulfate contents in the negligible range. However, the onsite soils are expected to be mildly to moderately corrosive to ferrous metal. Consequently, the hazard to structures and underground improvements from corrosive soil is expected to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-5** for testing prior to construction of the proposed improvements, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

<u>Lateral Spreading</u>

Lateral spreading is a phenomenon where large blocks of intact, non-liquefied soil move downslope on a liquefied substrate of relatively large aerial extent. The mass moves toward an unconfined area, such as a descending slope or stream-cut bluff, and is known to move on slope gradients as gentle as 1 degree. Lateral spreading only occurs in areas subject to liquefaction. As the project is not considered susceptible to liquefaction, the potential for lateral spreading within the NA is considered less than significant.

Regional Subsidence

Regional ground subsidence generally occurs due to rapid and intensive removal of subterranean fluids, typically water or oil. It is generally attributed to the consolidation of sediments as the fluid in the sediment is removed. The total load of the soils in partially saturated or saturated deposits is born by their granular structure and the fluid. When the fluid is removed, the load is born by the sediment alone and it settles. No reports of regional subsidence have been reported in the NA vicinity, and lack of intense removal of significant quantities of water or oil extraction in the area makes the potential for ground subsidence very low and less than a significant impact.

Induced Settlement

Similar to the RCA, the alluvial fan deposits across the majority of the NA are not typically prone to significant seismic settlement, however unconsolidated native soils and artificial fill prone to seismic settlement may be present locally. While it is true that the alluvium is susceptible to" some degree" of seismic settlement, it is, in general, only a very minor amount. The alluvium was deposited in a high-energy environment, and is relatively dense and high on the alluvial fan. This means that only a very minor amount of seismic settlement would be present. The potential for seismically induced settlement within alluvium is anticipated to be low (typically negligible) throughout the entire NA, due to the relatively dense nature of the alluvium. Code requires that individual projects evaluate the potential for seismic settlement. As the NA is located in a site of potential seismic settlement, as shown in **Figure 4.6-2**, the potential for seismically induced settlement is considered potentially significant. However, with incorporation of Mitigation Measure **MM GEO-6** by applying correct implementation of remedial grading and design recommendations, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Stability of Existing Slopes

The existing cut slopes of the inactive sand and gravel quarry within the NA will need to be evaluated if improvements are proposed near these slopes. The City's Development Code, Article III, Chapter 17.30 (Hillside Residential) indicates that areas with slopes equal to or steeper than 8 percent are considered a "hillside", and alternative grading and structural design techniques are required. The code indicates that, "Hillside Development Review is required for any subdivision or development within the Hillside Residential District. Therefore, similar to the RCA, the NA would require project-level geotechnical investigations specifically addressing slope stability and providing requisite mitigation measures required by the City. Future site-specific geotechnical investigations in areas of planned development are required to be conducted in order to evaluate the potential for slope instability. As such, with regulatory compliance, the risk of impact of natural slope stability is less than significant.

Stability of Proposed Slopes

Similar to the RCA, the NA design slopes cut into the native soil can be prone to instability, depending on the nature of the earth material underlying the slope. Design fill slopes may also be prone to instability if poorly constructed or constructed of unsuitable earth materials. Consequently, the hazard posed by unstable manufactured slopes is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-7,** in which slopes would be constructed in accordance with the recommendations of the geotechnical engineer, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Stability of Temporary Slopes

Similar to the RCA, slope or sidewall failure in temporary excavations for underground utilities or other structures could occur in unconsolidated soils. The risk of failure in temporary slopes is higher because they are generally cut at a much steeper gradient versus permanent manufactured slopes. Consequently, the hazard from temporary slopes is considered to be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-8,** in which specific recommended measures for excavation are in place to reduce the potential for temporary slope failure, impacts would be reduced to less than significant.

Threshold GEO-7: Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.

Rural/Conservation Area

Expansive soils underlying a foundation or slab, if left untreated, can cause damage to the structure, including heaving, tilting and cracking of the foundation. Differential movement in the building can result in damage to floors and walls, as well as door and window frames. Based on investigation within the RCA, the alluvial soils to have an EI of 20 or less. However, expansive soils may be present in hillside areas, such as those located in the RCA. As such, impacts would be potentially significant. However, with incorporation of Mitigation Measure **MM GEO-9,** for testing of expansive soils and the structural engineer to design a recommended foundation system to withstand any expansive potential, impacts would not exacerbate existing conditions and therefore would be reduced to a less than significant level.

Neighborhood Area

Similar to the RCA, the NA alluvial soils to have an EI of 20 or less. As the NA contains relatively flat topography, the chance of expansive soils remains low and therefore would not create a substantial direct or indirect risk to life or property. In addition, the proposed development within the NA would be subject to adherence to the minimum standards and seismic safety requirements contained within the current edition of the CBC. As such, the impacts would be less than significant.

Threshold GEO-8: Have soils incapable of adequately supporting use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

Rural/Conservation Area

The Plan would permit the development of up to 100 residences on private property in the RCA. As shown in **Section 4.16: Utilities and Service Systems**, there would be adequate capacity for wastewater and the soils would be capable for adequately supporting the 100 residences in the RCA. The slopes of the wastewater system generally follow the slope of the proposed grades from north to south. Gravity pipelines running west to east were placed at a minimum-acceptable slope to account for the relatively flat east-west grades, and to allow crossing of storm water pipelines. The north-south grades provide sufficient slopes to meet velocity requirements.

There are currently no specific locations for the residences in the RCA. As there is currently no infrastructure in the area, each new development would need further study of the soils to support new wells and septic tanks. As such, the Plan would implement Mitigation Measure **MM GEO-10** to reduce any impacts from soils to septic tanks for new developments within the RCA to a less than significant level.

Neighborhood Area

As shown in **Section 4.16: Utilities and Service Systems**, there would be adequate capacity for wastewater in the proposed future treatment capacity and sewer facilities within the NA. The closest existing sewer systems occur along the southeastern and southwestern edge of the NA. The proposed gravity sewer lines for the NA include 8-inch, 10-inch, 12-inch, 15-inch, 18-inch and 21-inch diameter piping, as shown in **Section 2.0: Project Description** in **Figure 2.0-12**. Therefore, no septic tanks are proposed for development for the NA, as it will be a function of the existing, and future planned, wastewater and sanitary sewer systems. The slopes of the wastewater system generally follow the slope of the proposed grades from north to south. Gravity pipelines running west to east were placed at a minimum acceptable slope to account for the relatively flat east-west grades, and to allow crossing of storm water pipelines. The north-south grades provide sufficient slopes to meet velocity requirements. As such, the Plan would have supported use of wastewater disposal systems and impacts would be less than significant.

Threshold GEO-9: Directly or indirectly a unique paleontological resource or site or unique geological feature.

Rural/Conservation Area and Neighborhood Area

Paleontological resources are valued for the information they yield about the history of the earth and its past ecological settings. A review of the cultural and historical resources was reviewed in **Section 4.4:**

Cultural and Tribal Cultural Resources. The Plan Area is currently undeveloped and vacant while the surrounding properties are located in an urbanized area that have been previously disturbed by construction activities. There are currently no unique geologic features located in the Plan Area.

While the discovery of paleontological resources in the Plan Area is considered unlikely, construction of the Plan would adhere to PRC Section 21083.2 which requires all earth-disturbing work to be temporarily suspended or redirected until a qualified paleontologist has evaluated the nature and significance of the resources, in accordance with federal, State, and local guidelines. In addition, Mitigation Measure **MM GEO-11** would be implemented in the case of any inadvertent discoveries where construction would halt in the immediate vicinity in the event of a paleontological resource is exposed, until a paleontologist can evaluate the significance of the find. With adherence to these regulatory requirements and measures, impacts would be less than significant.

CUMULATIVE IMPACTS

Rural/Conservation Area and Neighborhood Area

Related projects near the Plan Area are presented in **Table 3.0-1: Related Projects**, which includes those projects that are approved but not yet constructed, and those currently proposed and pending approval. This list of related projects describes proposed development within the City that could affect conditions in the Plan Area and was prepared based on data obtained from the City. **Table 3.0-1** provides information on the description, location, size, and status of these related projects. **Figure 3.0-4: Related Projects Location Map** illustrates the location of the related projects that have been identified in relation to the Plan based on their proximity to the Plan Area.

Generally, the geographic context for cumulative analysis of potential geology and soils impacts encompasses the geologically complex area where the relatively northwest-moving Peninsular Range Province meets the relatively southeast-moving Transverse Ranges Province. The Plan Area is at the southern edge of the Transverse Ranges geomorphic province, which is characterized by east-west trending mountain ranges including the San Bernardino Mountains and the San Gabriel Mountains. Seismic hazards can vary widely within this region as underlying conditions and proximity to an earthquake can present different levels of susceptibility to damage and injury to occupants. Geologic hazards, such as liquefaction, seismic shaking and earthquake faults, exist near the Plan Area, and because the entire region is seismically active, the Plan will be subject to seismic risks similar to those for other developments, and those located throughout the City and surrounding areas. Development of the Plan and elsewhere in the region could expose additional people and structures to potentially adverse effects associated with earthquakes, including seismic ground shaking. However, site-specific geotechnical studies required by local agencies in accordance with current building code standards would determine how future development projects must be designed to minimize the risk of loss, injury, or death involving earthquakes. Building code standards are based on the latest developments in seismic design and are routinely updated to include the best available science. Therefore, current and future development would be constructed in accordance with the most advanced seismic design standards.

Geology and soils impacts are generally site-specific and there is typically little, if any, cumulative relationship between the development of a project and development within a larger cumulative area (e.g., city-wide development). For example, development of the Plan would not alter geologic events or soil features/characteristics (such as ground shaking, seismic intensity, or settlement) at other locations; therefore, the Plan would not directly affect the level of intensity at which a seismic event or geologic hazard on an adjacent site is experienced. However, development of the Plan and future development in the City may expose more persons to seismic hazards.

The Plan and any future development projects would be required to comply with applicable State and local requirements, such as the City's Building Regulations/2016 CBC, and the City's Grading Standards. As with the Plan, future development would have potentially significant geology/soils impacts prior to mitigation and would also be required to have site-specific geotechnical investigations prepared to identify the geologic and seismic characteristics on a site and to provide recommendations for engineering design and construction to ensure the structural integrity of proposed development; these recommendations or mitigation measures would be incorporated into a project's final design. Compliance of individual projects with the recommendations of the applicable geotechnical investigation would prevent hazards associated with unstable soils, landslide potential, lateral spreading, liquefaction, soil collapse, expansive soil, soil erosion, and other geologic issues. Therefore, the Plan's contribution to cumulative geology and soils impacts would be less than significant with mitigation.

Impacts would not be cumulatively considerable.

MITIGATION MEASURES

The following mitigation measures have been identified to reduce potentially significant impacts related to geology and soils:

MM GEO-1 **Landslides**. The potential for seismically induced landslides and slope instability shall be investigated during future geotechnical studies. If the studies suggest slope instability is a concern, remedial recommendations to limit slope instability, such as construction of slope stability buttresses, installation of soil nails or anchors, or redesign of slopes, should be provided. Appropriate implementation of grading and slope stabilization recommendations is expected to reduce the impact of seismically induced landslides.

MM GEO-2 **Compressible Soils**. Future site-specific geotechnical investigations of planned development shall be conducted. These investigations should identify potentially compressible soils. Implementation of the recommended removal and re-compaction of the near surface soils should mitigate the significant portion of the soils that are prone to compression onsite. In addition, if deep artificial fill is to be placed in the abandoned quarry (or in other areas), specific recommendations for placement and settlement monitoring of these fills will be required. Delay in construction while the settlement of the deep artificial fills reduces to acceptable limits may be necessary. Geotechnical studies with recommendations specifically addressing these issues will be required if deep fills are planned.

MM GEO-3 **Erosion**. The potential for erosion can typically be reduced by appropriate paving of exposed ground surfaces, landscaping, providing terraces on slopes, placing berms or V-ditches at the tops of slopes, and installing adequate storm drain systems. Graded slopes must be protected until healthy plant growth is established. Typically, protection can be provided by the use of sprayed polymers, straw waddles, jute mesh or by other measures. Temporary erosion control measures must be provided during construction, as required by current grading codes. Such measures typically include temporary catchment basins and/or sandbagging to control runoff and contain sediment transport within the individual project sites. Correct implementation of these erosion control measures is expected to reduce the impact resulting from erosion.

MM GEO-4 **Rippability and Oversized Rock**. Future site-specific geotechnical investigations of planned development shall be conducted. These investigations must identify areas of hard rock and oversize rock. Adjusting the grades so as to not encounter the non-rippable rock will reduce the impact from the non rippable material to less than significant. Oversized rocks should be handled as recommended by the geotechnical consultants of the specific projects. Examples of oversized rock treatment includes placement in deeper fills, nonstructural areas, crushing, or disposed of offsite.

MM GEO-5 **Corrosive Soils**. Testing should be performed prior to construction of the proposed improvements within the RCA and NA. All concrete in contact with the soil shall be designed based on requirements of the California Building Code. All metals in contact with corrosive soil shall be protected in accordance with the recommendations of the manufacturer or a corrosion engineer.

MM GEO-6 **Settlement**. The potential for seismically induced settlement shall be investigated during future geotechnical studies. Based on these studies, loose, compressible soils prone to seismic settlement must be identified. Recommendations for removal and replacement or mitigation of soil prone to seismic settlement should be provided as part of geotechnical reports submitted to the City as part of the review of specific projects. Correct implementation of remedial grading and design recommendations is expected to reduce the impact of seismically induced settlement.

MM GEO-7 **Stability of Slopes**. Future site-specific geotechnical investigations of the planned development shall be conducted. These investigations must analyze this potential for slope instability in light of the proposed grading and development plans and underlying earth materials, and present recommendations for construction and adequate stability of manufactured slopes. Slopes shall be constructed in accordance with the recommendations of the geotechnical engineer for individual projects, California Building Code and City and/or County guidelines.

MM GEO-8 **Excavation**. Where excavations are made, the excavation wall may be shored, with shoring designed to withstand any additional loads, or the excavation walls may be flattened or "laid-back" to a shallower gradient. Excavation spoils should not be placed immediately adjacent to the excavation walls unless the excavation is shored to support the added load. Other measures used to reduce the potential for temporary slope failure include cutting and backfilling excavations in sections, and not leaving temporary excavations open for long periods of time. All CalOSHA regulations must be observed for excavations that will be entered by people. Following these measures is expected to reduce the impact posed by temporary slopes.

MM GEO-9 **Expansive Soils**. Testing within hillside areas of the RCA should be performed in planned development areas in order to evaluate the expansion potential of the near surface soil materials and prior to construction of the proposed foundations. Providing the results to the structural engineer will allow them to design a foundation system that is able to withstand the expansive potential of the near surface soil materials.

MM GEO-10 **Rural Development Design Review**. Development in the Rural/Conservation Area shall be subject to the requirements and review procedures of City Municipal Code 17.16.140 (Hillside Development Review). In addition to those requirements, applications for development in the Rural/Conservation Area shall include a septic system feasibility study prior to each new development as well as to obtain a well drill permit.

MM GEO-11 **Inadvertent Discoveries**. In the event that paleontological resources are exposed during ground-disturbing activities, work in the immediate vicinity of the find must stop until a qualified paleontologist can evaluate the significance of the find. Ground-disturbing activities may continue in other areas. If the discovery proves significant under CEQA, additional work, such as testing or data recovery, may be warranted. Should any prehistoric or historical Native American artifacts be encountered, additional consultation with NAHC-listed tribal groups should be conducted immediately.

LEVEL OF SIGNIFICANCE AFTER MITIGATION

With incorporation of Mitigation Measures **MM GEO-1** through **MM GEO-11**, impacts to geology and soils during construction and operation of the Plan would be less than significant.