5.10 GEOLOGIC AND SEISMIC HAZARDS

The purpose of this section is to describe the geologic and seismic settings of the Project area, identify potential impacts associated with implementation of the proposed alignment, and recommend feasible mitigation measures to reduce the significance of impacts identified. A *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California* (*Geotechnical Study*) was prepared by Earth Mechanics, Inc., dated July 12, 2006, to assess potential geologic hazards in the Project area (refer to Appendix 15.13, GEOTECHNICAL STUDY). The issues addressed in this section include risks associated with faults, strong seismic ground shaking, seismic related ground failure (such as liquefaction), landslides, and unstable geologic units and/or soils.

5.10.1 REGULATORY SETTING

UNIFORM BUILDING CODE

The Uniform Building Code (UBC) defines different regions of the United States and ranks them according to their seismic hazard potential. There are four types of these regions, which include Seismic Zones 1 through 4, with Zone 1 having the least seismic potential and Zone 4 having the highest seismic potential. The City of Corona is located in a Seismic Zone 4. Accordingly, any future development would be required to comply with all design standards applicable to Seismic Zone 4.

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act of 1972 is “to regulate development near active faults so as to mitigate the hazard of surface fault rupture.” The State Geologist (chief of the Division of Mines and Geology) is required to delineate Earthquake Fault Zones (formerly known as “Special Studies Zones” prior to January 1, 1994) along known active faults. Cities and counties affected by the zones must regulate certain development within the zones. They must withhold development permits for sites within the zones until geologic investigations demonstrate that the sites are not threatened by surface displacement from future faulting. Typically, structures for human occupancy are not allowed within 50 feet of the trace of an active fault.

CALIFORNIA UNIFORM BUILDING CODE

The State of California provides a minimum standard for building design through the California Building Code (CBC). The CBC is based on the UBC, with amendments for California conditions. Chapter 23 of the CBC contains specific requirements for seismic safety. Chapter 29 of the CBC regulates excavation, foundations, and retaining walls. Chapter 33 of the CBC contains specific requirements pertaining to site demolition, excavation, and construction to protect people and property from hazards associated with excavation cave-ins and falling debris or construction materials. Chapter 70 of the CBC regulates grading activities, including drainage and erosion control. Construction activities are subject to occupational safety standards

for excavation, shoring, and trenching as specified in Cal-OSHA regulations (Title 8 of the California Code of Regulations [CCR]) and in Section A33 of the CBC.

Chapter 16A, Division IV of the CBC, entitled "Earthquake Design," states that the "purpose of the earthquake provisions herein is primarily to safeguard against major structural failures or loss of life." The CBC and UBC regulates the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. The procedures and limitations for the design of structures are based on site characteristics, occupancy type, configuration, structural system, height, and seismic zoning. Seismic zones are mapped areas that are based on proximity to known active faults and the potential for future earthquakes and intensity of seismic shaking. Seismic zones range from 0 to 4, with areas mapped as Zone 4 being potentially subject to the highest accelerations due to seismic shaking and the shortest recurrence intervals.

SEISMIC HAZARDS MAPPING ACT

The Seismic Hazards Mapping Act (S-H Act) of 1990 provides a statewide seismic hazard mapping and technical advisory program to assist cities and counties in fulfilling their responsibilities for protecting the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes. Mapping and other information generated pursuant to the S-H Act is to be made available to local governments for planning and development purposes. The State requires: (1) local governments to incorporate site-specific geotechnical hazard investigations and associated hazard mitigation as part of the local construction permit approval process; and (2) the agent for a property seller or the seller if acting without an agent must disclose to any prospective buyer if the property is located within a Seismic Hazard Zone. The State Geologist is responsible for compiling seismic hazard zone maps.

CITY OF CORONA MUNICIPAL CODE

Chapter 15.36, Grading Regulations, of the City's *Municipal Code* sets forth regulations to control excavation, grading, and earthwork in accordance with the requirements for grading and excavation as contained in California Code of Regulations, Title 24, Appendix Chapter 33 (Uniform Building Code) with deletions, modifications or amendments to meet local conditions. A grading permit will be denied if the proposed work cannot be designed or performed in accordance with Chapter 15.36 of the City's *Municipal Code*.

An engineering geology report shall be prepared and submitted for any grading permit application associated with any development on a hillside site where geologic conditions are determined by the Public Works Director to have a substantial effect on existing and/or future site stability. The engineering geology report shall include a comprehensive description of the site topography and geology including the following, where necessary:

- Geologic map;
- Opinion regarding the adequacy of the proposed development from an engineering geologic standpoint;

- Opinion regarding potential instability impacts on adjacent properties;
- Description of the field investigation and findings;
- Conclusions regarding the effect of geologic conditions on the proposed project; and
- Specific recommendations for modifications to the grading plans, corrective grading and/or special techniques and systems to facilitate a safe and stable development.

CITY OF CORONA GENERAL PLAN

The Project site is located within the boundaries of the City of Corona and unincorporated Riverside County. Therefore, the Project is subject to the *City of Corona General Plan*, as well as any other applicable plans and policies for this jurisdiction. The applicable standards for geologic and seismic hazards to the proposed alignment are those within the *City of Corona General Plan* Public Health and Safety Element, as well as the UBC. Applicable goals and policies within the *City of Corona General Plan* Public Health and Safety Element relative to the proposed alignment are listed in the table below:

Table 5.10-1
Consistency Analysis with the *City of Corona General Plan*
Goals and Policies for Geologic and Seismic Hazards

GOALS AND POLICIES	PROJECT CONSISTENCY
Public Health and Safety Element Goals	
Goal 11.1: *Substantially reduce the known level of risk to loss of life, personal injury, public and private property damage, economic and social dislocation, and disruption of vital community services that would result from earthquake damage or other geologic disturbance.*	The proposed Project is required to comply with the UBC, State, County, and City regulations related to earthquake or other natural hazards. Follow-up field studies during PS&E would confirm that the Project design meets these safety standards, or would recommend specific engineering techniques to ensure compliance with regulations. Therefore, the Project would be consistent with Goal 11.1.
Public Health and Safety Element Policies	
Policy 11.1.1: *Require new development and re-development to be undertaken in a manner that is in compliance with current seismic and geologic hazard safety standards, as follows:* • *Regulate land uses in areas known to have, or have potential to have, significant seismic and/or other geologic hazards.* • *Require detailed scientific analyses of natural hazards to the satisfaction of the City Engineer as a condition of development approval within the City of Corona.*	This EIR, as well as the supporting *Hydrology Study* and *Geotechnical Study* prepared for the proposed Project, evaluates potential natural hazards associated with construction and operation of the Project. Additionally, the proposed Project is required to comply with the UBC, State, County, and City regulations related to earthquake or other natural hazards. Follow-up field studies during PS&E would confirm that the Project design meets these safety standards, or would recommend engineering techniques to ensure compliance with regulations. The follow up geotechnical report will evaluate potential stability impacts related to seismic ground shaking and liquefaction. The proposed soil nail wall will be designed considering the seismic conditions; the design may include longer nails, and smaller horizontal and vertical spacing of the nails. Stabilization fills or buttress fills may be required in front of cut slopes to limit slope displacement due to large earthquake events. In general, liquefaction impacts may be mitigated by various types of ground improvement methods, such as overexcavated, recompacted, densification, and/or compaction grouting. The follow up geotechnical report will recommend specific requirements to minimize impacts related to seismic ground shaking. The Project would be consistent with Policy 11.1.1.

Table 5.10-1 (Continued)
Consistency Analysis with the *City of Corona General Plan*
Goals and Policies for Geologic and Seismic Hazards

GOALS AND POLICIES	PROJECT CONSISTENCY
Policy 11.1.2: *Ensure the continued functioning of Essential Facilities following a disaster; prevention of loss of life from failure of Essential Facilities in an earthquake or other geologic hazard; and help prevent major problems for post-disaster response, such as difficult or hazardous evacuations or rescues, large numbers of injuries, and major clean-up or decontamination of hazardous materials as follows:* • Require the earthquake survival and efficient post-disaster operations be a primary concern relative to the siting, seismic design and construction standards for Essential Facilities. • Require that proposed Essential Facilities come under strict standards or seismic review prior to any approvals, including detailed site investigations for faulting, liquefaction and ground motion characteristics and application of the most current professional standards for seismic design. • As part of the development approval process for Essential Facilities, require site studies for ground shaking characteristics, liquefaction potential, and fault rupture potential. • Prohibit new Essential Facilities from locating in the Alquist-Priolo Special Study Zone of potential active fault. • Unless satisfactorily demonstrated that a building setback from an active or potentially active fault will not adversely impact public health, safety and welfare, new Essential Facilities shall not be located within 200 feet of an active fault or potentially active fault. Where fault identification is not feasible to determine, compensating building design characteristics shall be incorporated to the satisfaction of the City Engineer to reduce the potential for foundation and structural damage arising from secondary ground displacements in the fault zone.	The proposed Project is subject to discretionary review by the City of Corona Planning Commission and City Council. This EIR, as well as the supporting *Hydrology Study* and *Geotechnical Study* prepared for the proposed Project, evaluates potential natural hazards associated with construction and operation of the Project. Follow-up field studies during PS&E would confirm that the Project design meets these safety standards, or would recommend engineering techniques to ensure compliance with the most current engineering standards for seismic design. However, the Project would not meet the requirements of Policy 11.1.2. Due to the fact that the proposed roadway alignment is an essential facility and active faults traverse the Project site, the proposed Project would be inconsistent with Policy 11.1.2.
Policy 11.1.3: *Protect community safety and essential services by reducing the potential for property damage from liquefaction, and by collecting detailed information on liquefaction susceptibility throughout the City, as follows:* • *Determine the potential for liquefaction at proposed development and re-development sites prior to development approval and require that specific measures be implemented, as necessary, to prevent or reduce damage in the event of an earthquake.*	Refer to the response to Policy 11.1.1, above. The Project would be consistent with Policy 11.1.3.

Table 5.10-1 (Continued)
Consistency Analysis with the *City of Corona General Plan*
Goals and Policies for Geologic and Seismic Hazards

GOALS AND POLICIES	PROJECT CONSISTENCY
Policy 11.1.5: *Protect Essential Facilities from damage, loss of function or inaccessibility in the event of damage to natural or man made water reservoirs and protect sensitive facilities from detrimental consequences of inundation; and help ensure the rapid and orderly evacuation of populations in the potential inundation area, if necessary:* • *Prohibit the location of new Essential Facilities within the potential inundation area below water retention areas.* • *Avoid the development of Essential Facilities within the potential inundation area below a water retention area. Any exceptions and any expansion of Essential Facilities shall require discretionary approval by the Planning Commission.*	The Project site is not located within an area of potential inundation below water retention areas. Refer to Section 5.9, Hydrology and Water Quality, for a discussion regarding dam inundation. The Project would be consistent with Policy 11.1.5.

5.10.2 EXISTING CONDITIONS

REGIONAL GEOLOGIC SETTING

According to the *City of Corona General Plan* Environmental Resources Element, the City's Planning Area is situated in the Peninsular Ranges geomorphic province; this geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California. The province varies in width from approximately 30 miles to 100 miles in width. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks and Cretaceous igneous rocks of the Southern California batholith.

The proposed alignment traverses the northeast corner of the Santa Ana Mountains. These mountains lie within the Peninsular Range geomorphic province, which is characterized by its generally northwest trending mountains and geologic structures. The Peninsular Ranges Province is bound to the north by the Transverse Ranges, which is characterized by its east-west geologic structure and topographic grain, and on the east by the Colorado and Mojave Desert Provinces. The Corona Plain lies adjacent to this portion of the Santa Ana Mountains and represents a down faulted, alluvial filled linear trough at the base of the uplifted foothills.

The northeast part of the Santa Ana Mountains is sharply folded anticline, plunging northwest.[1] The northeast limb of the anticline exposes sedimentary bedrock units of the Cretaceous to Tertiary age. This limb of the anticline is narrow due to downfaulting along the Whittier-Elsinore Fault Zone. Below the sedimentary bedrock units are basement rocks of the Jurassic-age Bedford Canyon Formation.

[1] *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California*, prepared by Earth Mechanics, Inc., July 12, 2006.

Unconformable overlaying and intruding the Bedford Canyon Formation is the Santiago Peak Volcanic of Cretaceous-age.

The Elisnore Fault Zone lies at the base of the Santa Ana Mountains and is a major active right-lateral, strike-slip fault zone of the San Andreas Fault System. The fault separates two major structural blocks of the northern Peninsular Ranges. East of the fault zone is the Perris Block and west is the Santa Ana Mountains Block.

GENERAL SITE GEOLOGY

Soils

The Project site is underlain by Cretaceous and Tertiary sedimentary bedrock units within the foothills of the Santa Ana Mountains, as well as by alluvial fan and channel deposits in the Corona Plain. Man-made fill has been placed in Wardlow Canyon, Mabey Canyon, and at the southern terminus of the Project site.

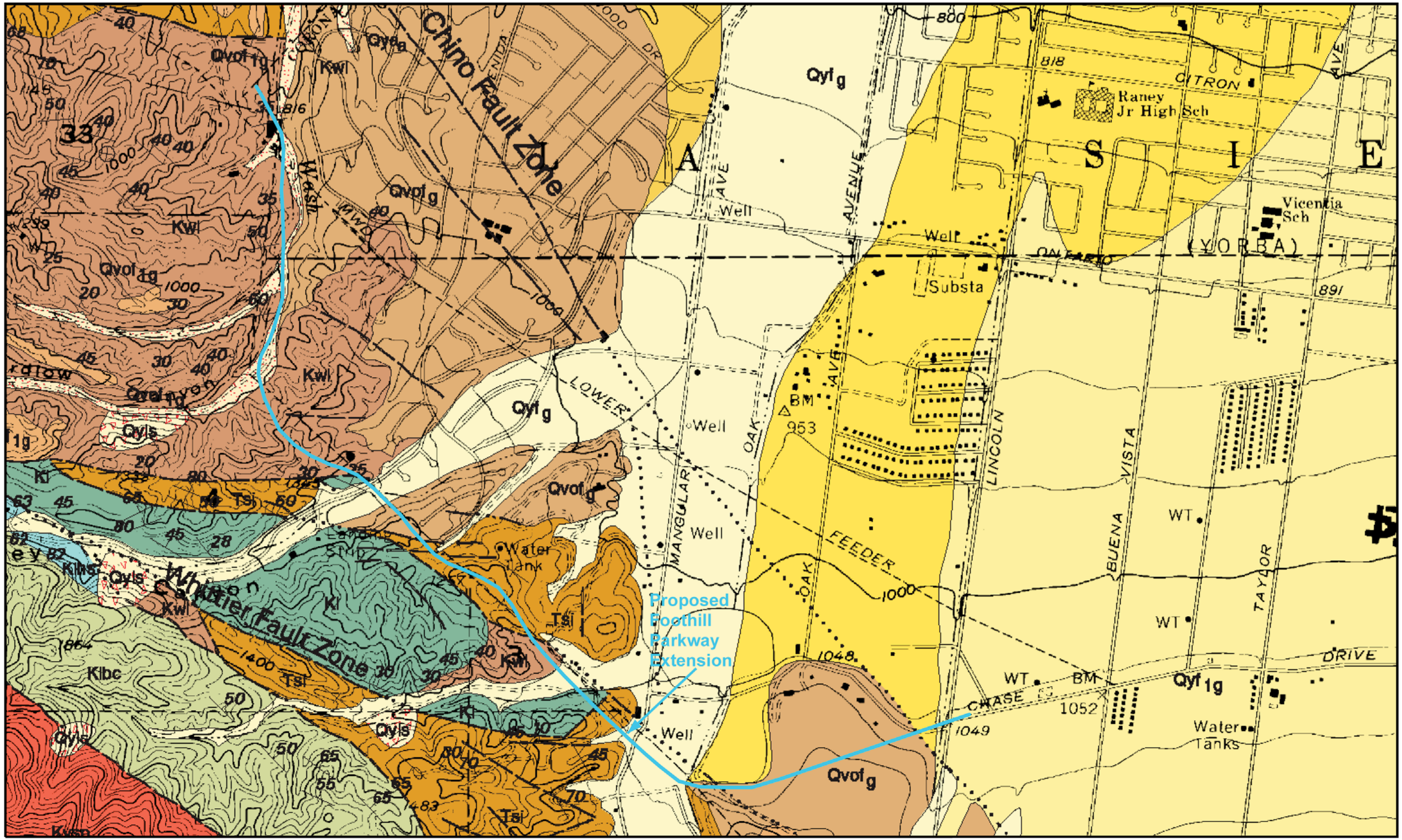
Soils which underlie the Project site include man-made fill, young alluvial channel deposits, young alluvial fan deposits, old and very old alluvial fan deposits, Paleocene Silverado Formation, Williams and Ladd Formations (undifferentiated), and Ladd formation.[2] These geologic units are described below and are illustrated on Figure 5.10-1, GEOLOGIC MAP.

Man-Made Fill

Deposits of man-made fill exist locally in areas of Wardlow Canyon, Mabey Canyons, as well as the southern terminus of the proposed alignment, where previous and on-going developments have occurred. In most cases, these man-made fills were likely derived from nearby geologic units, and thus would be similar in lithology. However, wide variability in material type can occur in man-made fills, due to differences in the source materials (i.e., varied bedrock and alluvial units), and also because of variations in the way the fills are placed. Important factors associated with man-made fill include the degree to which the area beneath the fill was prepared before fill placement and the degree to which the fill materials were compacted. Man-made fill is considered “engineered” if records of compaction tests and remedial removal procedures used during fill placement are available. If no records are available, the fill is considered “non-engineered”.

Man-made fill exists in Wardlow Canyon associated with the construction and backfill of the Metropolitan Water District (MWD) Main Feeder. Man-made fill was used in the construction of the equestrian center bridal corals, trails, roadways, and trailer pads. According to the *Geotechnical Study*, it is assumed that much of this fill is non-engineered.

[2] Ibid.



Source: Gray et al., 2002, Geologic Map of the Corona South 7.5" Quadrangle, USGS OFR 02-21.

Qyf	Young alluvial fan deposits (Holocene and late Pleistocene)
Qya	Young alluvial channel deposits (Holocene and late Pleistocene)
Qvof	Very old alluvial fan deposits (early Pleistocene)
Tsi	Silverado Formation (Paleocene)
Kwl	Williams and Ladd Formations, undifferentiated (Upper Cretaceous)
Kl	Ladd Formations (Upper Cretaceous)

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No Scale

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Geologic Map

Figure 5.10-1

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Additionally, another sequence of man-made fill exists in Mabey Canyon associated with the flood control basin. According to the *Geotechnical Study*, it is assumed that this fill was placed under controlled engineered conditions during construction of the basin.

Man-made fill also exists near the southern terminus of the proposed roadway alignment. This fill was placed as part of a residential development and construction of the initial phase of the extension of Foothill Parkway. According to the *Geotechnical Study*, it is assumed that this fill was placed under controlled conditions.

Young Alluvial Fan Deposits (Qyf)

Young alluvial fan deposits consist of sand, gravel, and boulder deposits that are derived from volcanic sedimentary units of the Santa Ana Mountains. Young alluvial fan deposits located on the Project site are concentrated in the bottom of Mabey and Hagador Canyons.

Young Alluvial Channel Deposits (Qya)

Young alluvial channel deposits consist of unconsolidated, medium- to fine-grained sands, gravels, cobbles, and boulders. Alluvial deposits typically exhibit poor sorting, moderately to poorly developed lenticular bedding, and local cross bedding. In the bottom of Wardlow Canyon young alluvial channel deposits exist.

Old and Very Old Alluvial Fan Deposits (Qof)

Old and very old alluvial fan deposits consist of moderately to well consolidated gravel and cobble deposits within a dirty sand matrix. The alluvial clasts correspond closely to the sedimentary and basement-complex types found nearby in the Santa Ana Mountains, indicating local derivation. The very old deposits are present along the east side of Wardlow Canyon and the southeast side of Mabey Canyon by the flood control basin. Old and very old alluvium is also present near the southern terminus of the proposed roadway alignment.

Paleocene Silverado Formation (Tsi)

Paleocene Silverado Formation contains marine and non-marine units, which consist of reddish-brown to buff clayey sandstone, siltstone, and conglomerate. The contact between the Silverado formation and the underlying Cretaceous rocks is an unconformity that represents an episode of deformation and deep erosion. In the vicinity of the proposed roadway alignment, the Silverado formation lies in fault contact with the Ladd formation. The Silverado formation sandstones are generally massive in size and poorly to moderately indurated. Furthermore, slope stability is generally moderate to good for natural and cut slopes in the Silverado formation. The central portion of the proposed Foothill Parkway extension, between Mabey and Hagador Canyon, is underlain by the Paleocene Silverado Formation.

Williams and Ladd Formations (undifferentiated) (Kwl)

Cretaceous units of the undifferentiated Williams and Ladd formations underlie the northern portion of the Foothill Parkway extension from the northwest side of Mabey Canyon extending through Wardlow Canyon, to the northern roadway terminus. This sedimentary unit consists of buff to gray colored sandstone, cobble and small boulder conglomerates, siltstone, and shale. The sandstone is massively bedded as well as locally hard and cliff-forming. This formation underlies the steepest terrain along the proposed alignment and the lack of landslides in the area suggests good natural slope stability.[3] Along portions of the Whittier Fault, the undifferentiated Williams and Ladd formation is juxtaposed with the Silverado formation.

Ladd Formation (Kl)

The Ladd formation is composed of Cretaceous marine units, which contain conglomerate, sandstone, siltstone, and shale. The sandstone and conglomerate are thickly bedded. Bedrock units of the Ladd formation are present in the central portion of the proposed Foothill Parkway extension.

FAULTS

The proposed alignment is located within a seismically active region and would be subject to seismically related geological hazards. Any specific area within southern California is subject to seismic hazards of varying degrees, depending on the proximity and the earthquake potential of nearby active faults, and the local geological and topographic conditions, which can either amplify or attenuate the seismic waves. The principal seismic hazards that are generally investigated for most roadway projects in southern California should also be considered during the design phase of a proposed alignment. The principal seismic hazards to properties are surface rupturing of earth materials along fault traces and damage to structures and foundations due to strong ground motions generated during earthquakes. These hazards are related to the principal active faults in the region, which include the Whittier-Elsinore, Chino, San Andreas, San Jacinto, and Newport-Inglewood faults. The proposed alignment crosses the Whittier-Elsinore and Chino faults.[4]

The fault classification criteria adopted by the California Geological Survey defines Earthquake Fault Zones along active or potentially active faults. Based on the classification system of the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) of 1972, revised in 1997, an active fault is defined as a fault that has had surface rupture in the Holocene times (about the last 11,000 years).[5] A fault that has ruptured during the last 1.8 million years (Quaternary time), but is not proven by direct evidence to have moved or not moved within the Holocene, is considered to be potentially active.[6] Any fault older than Pleistocene (1.8 million years) is considered inactive.

The Alquist-Priolo Act is primarily intended to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Alquist-Priolo

[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.

Act requires the State Geologist to delineate regulatory zones known as "Earthquake Fault Zone" along faults that are "sufficiently active" and "well defined". The Alquist-Priolo Act also requires that cities and counties withhold development permits for sites within an Earthquake Fault Zone until geologic investigations demonstrate that the sites within these Earthquake Fault Zones are not threatened by surface displacement from future faulting. According to the *Geotechnical Study*, review of the State of California Alquist-Priolo Earthquake Fault Zone Map for the Corona South Quadrangle indicated that the proposed alignment is located within a defined earthquake fault zone boundary.

According to the *City of Corona General Plan*, the Elsinore Fault Zone splays into two segments: the Chino-Central Avenue Fault and the Whittier Fault. Along the southwestern portion of the City, the Elsinore Fault zone is referred to as the Glen Ivy Fault.[7] The Glen Ivy Fault consists of two strands, the Glen Ivy North Fault and the Glen Ivy South Fault. Both strands of the Glen Ivy Fault are included in an Alquist-Priolo Earthquake Fault zone, which is located along the southwest boundary of the City and through the Temescal Valley portion of the City's Sphere of Influence (SOI). The Glen Ivy Fault, at its closest, is located approximately 3.4 miles west of central Corona. The fault extends northwest from approximately Lake Elsinore for a distance of approximately 23.6 miles to approximately west of Corona, where it splits into two different fault segments. According to the City's *General Plan*, the Glen Ivy Fault could produce an earthquake with a maximum magnitude of 6.8 on the Richter scale.

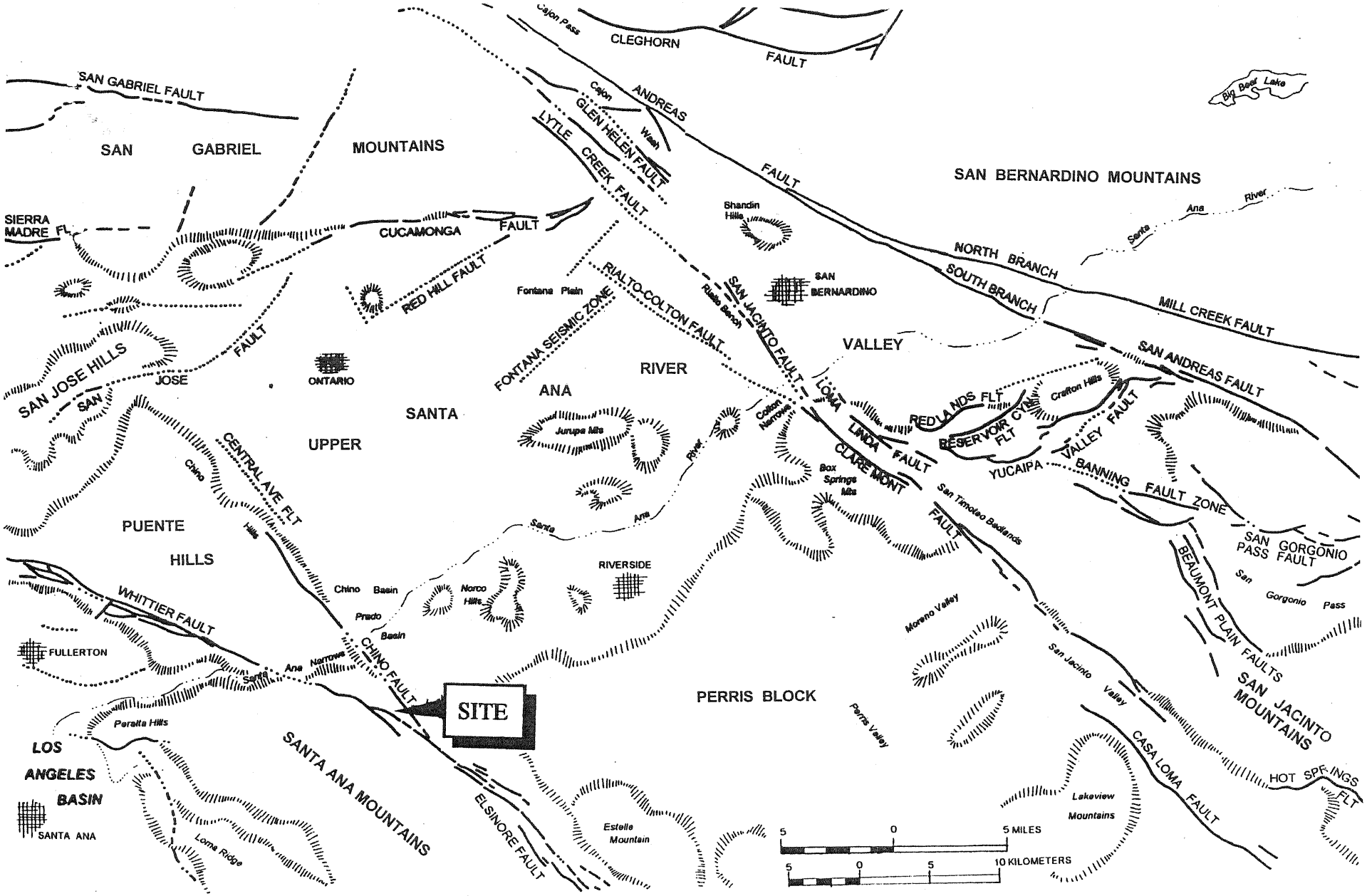
Several active faults are located within a close proximity to the Project site (refer to Figure 5.10-2, FAULT LOCATION MAP). According to the *Geotechnical Study*, the most significant geologic feature located in close proximity to the proposed Foothill Parkway Extension is the confluence of the following three major fault zones: 1) the Elsinore Fault Zone, 2) the Whittier Fault Zone, and 3) the Chino Fault Zone. The seismic characteristics of the major fault zones within close proximity to the Project site are described below.

Chino Fault Zone

According to the *Geotechnical Study*, the Chino Fault Zone diverges from the Whittier-Elsinore Fault south of the City of Corona and extends north through Chino Hills, ending in the Los Serranos suburb of the City of Chino Hills. The tectonic geomorphology of the Chino Fault Zone indicates predominately right-lateral strike-slip motion with a component of reverse-oblique movement, based on the offset ridgeline, deflected drainages, and beheaded drainages in the Chino Hills. The Chino Fault is considered active by the State of California and an Alquist-Priolo Special Study Zone has been established around the fault. Furthermore, the Chino Fault Zone has a long-term slip rate ranging from 0.7 to 2.2 millimeters per year, and has the potential to generate an earthquake with a magnitude of 6.5 to 7.0 on the Richter scale.[8] This fault traverses the Project site near the southern terminus of the proposed alignment, where the fault is buried by quaternary alluvial deposits.

[7] *City of Corona General Plan*, EIP Associates, March 14, 2004.

[8] *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California*, prepared by Earth Mechanics, Inc., July 12, 2006.



Source: Geotechnical Study for Preliminary Engineering/Environmental Document: Foothill Parkway Westerly Extension, Earth Mechanics, Inc., July 12, 2006.

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Fault Location Map

Figure 5.10-2

Whittier-Elsinore Fault Zone

The Whittier Fault branches away from the Elsinore (Glen Ivy) Fault at a point west of central Corona, outside of the City boundaries, and extends northwest for a distance of approximately 23 miles through the Santa Ana Mountains and into the Whittier Hills.[9] According to the *Geotechnical Study*, the northwest-trending Whittier-Elsinore Fault Zone extends nearly 150 miles from the Mexican border to the northern edge of the Santa Ana Mountains where it crosses the Project site. This fault crosses the central portion of the proposed Foothill Parkway extension. Geomorphic evidence indicates that the Whittier-Elsinore Fault is considered capable of seismic offsets of up to approximately 20 feet.[10] Additionally, these offset sediments were suggested of being exposed in trenches to indicate a 200- to 300-year recurrence interval for ground rupturing earthquakes.[11]

The Whittier-Elsinore Fault Zone is considered capable of generating earthquakes with a magnitude of 7.0 to 7.5 on the Richter scale.[12] This fault is considered active by the State of California and an Alquist-Priolo Special Study Zone has been established around this fault.

San Andreas Fault Zone

The San Andreas Fault is the dominant active fault in California, and is located approximately 28.3 miles northeast (at the nearest point) of the Project site. The San Andreas Fault is considered to be the main element of the boundary between the Pacific and the North American Plate tectonic plates. The fault extends approximately 625 miles in length from Cape Mendocino (to the north) and extending Salton Sea (to the south). In southern California, the Carrizo, Mojave, and Coachella Valley segments of the fault are potential sources of future earthquakes that could result in strong ground shaking along the proposed Foothill Parkway extension. This active fault has generated the largest known earthquakes in California, and is considered capable of generating earthquakes with a magnitude of 7.5 to 8.0 on the Richter scale.[13]

San Jacinto Fault Zone

The San Jacinto Fault is historically the most seismically active fault zone in California and is located approximately 22.8 miles northeast of the Project site. Segments of this fault extend from San Bernardino southeast more than 190 miles through the Imperial Valley, and into northern Baja California. At the northern end of this fault, a right-lateral strike-slip fault appears to merge with the San Andreas Fault. Over the past century, the San Jacinto Fault has produced at least ten earthquakes, all with approximate magnitudes of 6.0 or greater on the Richter scale. Geologic, geodetic, and seismologic observations generally point to an average slip rate of eight to 12 millimeters per year during Quaternary time. This fault is considered

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[9] *City of Corona General Plan*, EIP Associates, March 14, 2004.

[10] *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California*, prepared by Earth Mechanics, Inc., July 12, 2006.

[11] Ibid.

[12] Ibid.

[13] Ibid.

capable of generating earthquakes in the magnitude of 7.0 to 7.5 on the Richter scale.

Newport-Inglewood Fault Zone

The Newport-Inglewood Fault is a broad fault zone consisting of discontinuous faults and folds striking southeastward from near Santa Monica across the Los Angeles basin to Newport Beach. This fault is located approximately 22.3 miles southwest (at the closest point) of the Project site. The surface trace of the fault zone is discontinuous in the Los Angeles Basin, but the fault zone can easily be noted by the existence of a chain of low hills extending from Culver City to Signal Hill. To the south of Signal Hill, the fault roughly parallels the coastline until just south of Newport Bay, where it then travels offshore and becomes the Newport-Inglewood/Rose Canyon Fault Zone. These various faults constitute a system that is more than 150 miles long. The Newport-Inglewood Fault was the source of the destructive 1933 Long Beach earthquake. This fault represents a major hazard to the densely populated Los Angeles basin, which includes Orange County. This fault is considered capable of generating earthquakes of approximately 7.0 in magnitude on the Richter scale.[14]

San Joaquin Hills Blind Thrust Fault

The uplift of the folded sedimentary rocks of the San Joaquin Hills Blind Thrust Fault is produced by a southwest dipping blind thrust fault that extends at least 23.6 miles from northwestern Huntington Mesa to Dana Point and comes within 1.2 miles of the ground surface.[15] This fault is approximately 20 miles from the Project site. Uplift rates of this fault have been estimated to be between 0.25 and 0.5 millimeters per year and could generate earthquakes with a magnitude of approximately 6.6 on the Richter scale.[16]

GEOLOGIC AND SEISMIC HAZARDS

As described above, the Project site is bordered by major, active fault systems, making the site a historically active seismic area. Geologic and seismic hazards are described as hazards that could impact a site due to the surrounding geologic and seismic conditions. Potential geologic hazards include landslides, erosion, collapsible and expansive soils, subsidence, and volcanic eruptions, whereas potential seismic hazards include activities that occur during an earthquake such as ground shaking, ground rupture, and liquefaction. According to the *Geotechnical Study*, the most significant faults relative to the Project area are listed below in Table 5.10-2, POSSIBLE EARTHQUAKE EFFECTS, along with estimates of their maximum earthquake magnitude and the peak bedrock acceleration.

[14] Ibid.
[15] Ibid.
[16] Ibid.

Table 5.10-2
Possible Earthquake Effects

Fault	Style of Faulting	Maximum Credible Earthquake Magnitude	Approximate Distance From Site (miles)	Peak Bedrock Acceleration (g)
Whittier-Elsinore (WEE)	Strike-slip	7.5	< 1.0	0.71
Chino Fault (CNO)	Strike-slip	7.0*	< 1.0	0.58
San Andreas Fault (SAC)	Strike-slip	8.0	28.3	0.22
San Jacinto Fault (SJO)	Strike-slip	7.5	22.8	0.17
Newport-Inglewood-Rose Canyon/E (NIE)	Strike-slip	7.0	22.3	0.13

Notes:
* The text in the *Geotechnical Study* indicate the magnitude of an earthquake for this fault ranges between 6.5 and 7.0.
-Style of faulting as indicated in "A Technical Report to Accompany the Caltrans Seismic Hazard Map," by Mualchin (Caltrans, 1996b).
-Distance from fault to the Project site was obtained from the Caltrans Seismic Hazard Map (1996a).
-Peak bedrock accelerations are based on attenuation relationship of Mualchin (1996b) and the Caltrans Seismic Hazard Map (1996a).
Source: *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California*, Earth Mechanics, Inc., July 12, 2006.

The above table indicates that a maximum peak ground acceleration of 0.71g would be felt at the Project site as a result of a maximum earthquake magnitude of 7.5 on the Whittier-Elsinore Fault, which traverses the central portion of the Project site. Additionally, a maximum probable earthquake of magnitude 6.5 along the Chino Fault, which crosses the southern portion of the Project site, would create a peak site ground acceleration of 0.58g. Also, a maximum probable earthquake of magnitude 8.0 on the San Andreas Fault would create a peak site ground acceleration of 0.22g at the Project site.

Historically, the Corona region has generally been spared of major destructive earthquakes. However, based on a search of earthquake databases of the United States Geological Survey (USGS) National Earthquake Information Center, several major earthquakes with a magnitude of 6.0 on the Richter scale or greater have been recorded within approximately 100 kilometers of the City since 1976. Therefore, all development within the City of Corona and the surrounding region is subject to seismic hazards. Development standards would require the Project to comply with appropriate seismic design criteria from the UBC, adequate drainage facility design, and preconstruction soils and grading studies.

The City's *General Plan* Public Health and Safety Element has identified various implementation programs with respect to fault rupture and other geologic disturbances. These programs specify various requirements including: detailed geologic investigations are to be conducted, in conformance with guidelines of the California Division of Mines and Geology (CDMG), for all construction of transportation infrastructure in an Alquist-Priolo Special Study Zone; construction of essential facilities[17] within 200 feet of an active fault or potentially active fault; and

[17] The *City of Corona General Plan* Public Health and Safety Element defines "Essential Facilities" as buildings, services, and infrastructure that serve or house people and include hospitals and other medical facilities, fire, police and emergency services; water, electricity and natural gas supply infrastructure; sewage and solid waste disposal; communications infrastructure; transportation infrastructure.

field information is to be developed as part of any CEQA investigations, and geologic reports by the City and/or County geologists should be kept current and accessible for use in report preparation, geologic reviews, and policy development.

Additionally, the City's *General Plan* Public Health and Safety Element has identified various implementation programs to be carried out by the City and County affecting seismic safety of critical facilities. These programs include: detailed site studies for fault rupture potential are to be conducted as background to the design process for critical facilities under City and County discretionary approval; existing critical facilities are to be reviewed for any significant siting, design, or construction problems that would make them vulnerable in an earthquake, and the findings shall be incorporated into emergency operation plans as well as addressed in longer-term programs of facilities upgrading or relocation; unless satisfactorily demonstrated that a building setback from an active or potentially active fault will not adversely impact public health, safety, and welfare, new Essential Facilities shall not be located within 200 feet of an active fault or potentially active fault.

GEOLOGIC HAZARDS

Landslides

Slope instability is a condition that can be pre-existing and can pose a negative condition for a project. Landslides often occur along pre-existing zones of weakness within bedrock (i.e., previous failure surfaces). Additionally, landslides have the potential to occur on over-steepened slopes, especially where weak layers, such as thin clay layers, are present and dip out-of-slope. Landslides can also occur on antidip slopes, along other planes of weakness such as faults or joints. Local folding of bedrock or fracturing due to faulting can add to the potential for slope failure. Groundwater is very important in contributing to slope instability and landsliding. Additionally, other factors that contribute to slope failure include undercutting by stream action and subsequent erosion, as well as the mass movement of slopes caused by seepage or cyclical wetting and drying.

Geologic mapping indicates no landslides within the proposed Project area (including grading limits).[18] However, two landslides have been mapped within ½-mile of the proposed roadway centerline in bedrock units of the Paleocene Silverado, Williams and Ladd Formations.[19] These landslides are located within the Whittier Fault Zone and suggest that bedrock units within this fault zone may be more susceptible to sliding due to severe shearing and fracturing associated with tectonic stress.

Unstable Cut and Fill Slopes

Construction of a project can trigger slope instability due to the exposure of unsupported planes of weakness or removal from material that was previously resisting slope failure. The stability of cut and fill slopes is primarily a function of the steepness of the slope, the character of the material that the slope is composed of,

[18] *Geotechnical Study for Preliminary Engineering/Environmental Document Foothill Parkway Westerly Extension City of Corona, Riverside County California*, prepared by Earth Mechanics, Inc., July 12, 2006.
[19] Ibid.

and groundwater conditions. In general, these conditions can be readily investigated and analyzed, and slopes with favorable stability can be designed and constructed.

Collapsible and Expandable Soil

Expansive soils generally result from having high percentages of expansive clay minerals, such as montmorillonite. These fine-grained soils can undergo substantial increases and decreases in volume, with an increase and decrease in water content respectively. If not adequately addressed, expansive soils can cause extensive damage to structures and paving. Remedial earthwork or in-situ treatment of expansive soils can reduce potential adverse impacts to structures and paving. Also, structures can be designed to accommodate forces due to soil expansion.

Trench-Wall Stability

The stability of trench walls depends largely on the character of the material to be excavated, as well as the size and shape of the excavation. In most cases, intact bedrock tends to be stable, requiring less support, whereas the softer materials, such as alluvium and man-made fill, would most likely be more unstable and require more support. The presence of groundwater is also an important factor and excavations below groundwater may require temporary dewatering to achieve stability.

Land Subsidence

If a project involves extraction of fluids or gas, the potential exists for causing subsidence. For example, in the area of Wilmington, California, years of oil extraction with no mitigation resulted in several feet of subsidence. Similarly, in the San Joaquin Valley, several years of groundwater extraction may have resulted in significant subsidence. Depending on whether the area is developed, subsidence can cause extension problems, which can be very costly to mitigate. However, there are no known ongoing or planned large-scale extractions of groundwater, gas, oil, or geothermal energy that would cause subsidence in the Project area.[20]

Volcanic Hazard

If a project was located in proximity to an active volcano, and located downhill in a topographically unprotected location, there would be the potential for damage from lava flow. However, there are no active or potentially active volcanoes in the region of the proposed roadway alignment. Therefore, there are no volcanic hazards associated with the proposed alignment.

SEISMIC HAZARDS

Seismic hazards are associated with earthquakes, and consist of ground shaking, rupture, liquefaction, differential compaction, or seismic settlement and other phenomenon. The Project site, as with much of California, is susceptible to ground shaking generated during earthquakes on nearby faults. Potential seismic hazards and how they may affect the proposed alignment are discussed below.

[20] Ibid.

Surface Fault Rupture

Surface rupture occurs when movement on a fault deep within the earth breaks through to the surface. Fault ruptures usually follow preexisting faults, which are zones of weakness. Ruptures may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they are accompanied by shaking, while fault creep is the slow rupture of the earth's crust. The proposed alignment is crossed by two active faults, the Whittier-Elsinore Fault and the Chino Fault. Additionally, Alquist-Priolo Special Study Zones have been established by the State of California around these faults. Therefore, the southern two-thirds of the proposed roadway alignment lies within these zones.

Ground Shaking

The potential for strong ground motion affects most of California, and as with similar facilities the Foothill Parkway extension would be subject to strong ground motion, as portions of the proposed alignment traverse two fault zones. Strong ground motion occurs as energy is released during an earthquake, and the intensity depends on the distance between faults and roadway alignments, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the roadway alignment. Refer to Table 5.10-1, above, for the maximum credible earthquake magnitude and acceleration of the major faults surrounding the Project site. According to the *Geotechnical Study, e*arthquakes occurring on the faults that cross the Project site extension will likely generate the largest ground motions.

Liquefaction

Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during a seismic event and is associated primarily with relatively loose, saturated fine- to medium-grained cohesionless soils. Seismic ground shaking of relatively loose, granular soils that are saturated or submerged can cause the soils to liquefy and temporarily behave as a dense fluid. Liquefaction is caused by a sudden temporary increase in pore-water pressure due to seismic densification or other displacement of submerged granular soils. Liquefiable soil conditions are not uncommon in alluvial deposits in moderate to large canyons and could also be present in other areas of alluvial soils where the groundwater level is shallow. Bedrock units, due to their dense nature, are unlikely to present a liquefaction hazard.

The proposed Foothill Parkway extension traverses a number of large, alluvial-filled canyons, including Wardlow, Mabey, and Hagador Canyon. Additionally, alluvial sediments commonly have an unconsolidated nature and have the potential to experience shallow groundwater conditions; therefore, areas that share these characteristics have the potential to result in liquefaction.

Seismically-Induced Landsliding

If subjected to strong seismic shaking, existing landslide masses and slopes composed of weak materials could move downhill. No existing landslides have been mapped along the proposed alignment. However, the potential for heavily sheared

and fractured materials should be considered due to the proximity of the proposed alignment to the Whittier-Elsinore Fault Zone. The susceptibility of existing weak materials, on natural or manufactured slopes, to movement during strong seismic shaking can be estimated using information obtained from geologic field investigations and laboratory testing.

Seismically-Induced Settlement and Differential Compaction

Seismically-induced settlement and differential compaction occurs when relatively soft or loose soils experience a reduction in volume (compaction) caused by strong ground motion. Soil conditions subject to these hazards include unconsolidated soils or areas where weak soils of variable thickness overlie firm soil or bedrock. The type of materials that would most likely experience seismically-induced settlement and differential compaction are deposits of alluvium and possibly poorly constructed man-made fills. If structures were built on such soil conditions, settlement damage could result in the event of strong seismic shaking.

Earthquake-Induced Flooding

Earthquake-induced flooding may occur if strong seismic shaking causes the failure of a dam that retains water. Lake Matthews is approximately seven miles southeast of the Corona city limits and approximately 13 miles east of the Project site. Failure of either dam would cause flooding along the Temescal Wash in the eastern and northeastern portions of the City. As such, Lake Matthews does not pose a significant flood risk to the Project site. Prado Basin and Dam are located approximately five miles west of the City of Corona and approximately ten miles northwest of the Project site. The flow pattern from this dam is westward away from Corona, and as a result Prado Basin and Dam do not pose a significant flood risk to the Project site.

The only dam-type facility within close proximity to the proposed alignment is the Mabey Canyon Debris Basin.[21] This facility is used for flood control and typically does not retain water year round. The probability is very low that strong seismic shaking would occur, during the limit time, when the retention basin is holding water; therefore the downstream hazard of seismically-induced flooding is low.[22]

Other Seismic Hazards

Other potential seismic hazards include tsunamis and seiches. A tsunami is a great sea wave, commonly referred to as a tidal wave, produced by a significant undersea disturbance such as tectonic displacement of the sea floor associated with a large, shallow earthquake. A seiche is an oscillation of a body of water in an enclosed or semi-enclosed basin (such as a reservoir, harbor, lake, or storage tank) resulting from earthquakes or other sizable environmental disturbances. Due to the Project site's distance from the Pacific Ocean and the absence of lakes or other large bodies of water in the immediate area, the potential for tsunamis and seiches impacting the Project site is not considered a significant risk.

[21] Ibid.
[22] Ibid.

5.10.3 STANDARDS OF SIGNIFICANCE

SIGNIFICANCE CRITERIA

In accordance with CEQA, the effects of a project are evaluated to determine if they would result in a significant adverse impact on the environment. An EIR is required to focus on these effects and offer mitigation measures to reduce or avoid any significant impacts that are identified. The criteria, or standards, used to determine the significance of impacts may vary depending on the nature of the project. Geologic and seismic impacts resulting from the implementation of the proposed alignment could be considered significant if they cause any of the following results.

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving (refer to *Impact Statements 5.10-2* through *5.10-5*);
    - 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;
    - Strong seismic ground shaking;
    - Seismic-related ground failure, including liquefaction; or
    - Landslides.
- Result in substantial soil erosion or the loss of topsoil (refer to Section 10.0*,* EFFECTS FOUND NOT TO BE SIGNIFICANT);
- Be located on a geologic unit or soil that is unstable, or that would become unstable and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction or collapse (refer to *Impact Statements* 5.10-1 and 5.10-6);
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property (refer to Section 10.0*,* EFFECTS FOUND NOT TO BE SIGNIFICANT); and/or
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of waste water (refer to Section 10.0*,* EFFECTS FOUND NOT TO BE SIGNIFICANT).

Based on these standards, the effects of project implementation have been categorized as either a “less than significant impact” or a “potentially significant impact”. If a potentially significant impact cannot be reduced to a less than significant level through the application of goals, policies, standards or mitigation, it is categorized as a significant and unavoidable impact.

Potential impacts associated with the proposed alignment have been identified. The impacts are categorized according to topic, then numbered consecutively under each

category. The numbered mitigation measures in Section 5.10.5, MITIGATION MEASURES, directly correspond with the numbered impact statements.

5.10.4 IMPACTS

SOILS

5.10-1 *Grading activities would be required to prepare the Project site for the proposed roadway alignment, subsequently resulting in the exposure of soils to short-term erosion by wind and water.* ***Significance: Implementation of recommended Mitigation Measures 5.9-1a and 5.9-1c in Section 5.9, HYDROLOGY AND WATER QUALITY, would reduce impacts to less than significant levels.***

Impact Discussion: According to the *Geotechnical Study*, the Project site contains areas along the proposed roadway alignment that would require man-made fill. If no records are available that verify compaction tests and remedial removal procedures used during the placement of existing man-made fill along the proposed roadway alignment, the fill would be considered "non-engineered". Therefore, depending upon the specific on-site conditions of the soil, the Project Contractor would be required to remove the "non-engineered" fill as part of the grading associated with the proposed alignment. Due to the low density and compressible nature of existing young alluvial channel deposits within the Project site, remedial removals would be required prior to placement of engineered fills. Grading operations and the resultant manufactured embankments could increase the potential for erosion and siltation both during and after the construction phase of the Project. In order to mitigate the potential effects of erosion on-site, temporary and permanent erosion control measures would be required, such as the use of sandbags, hydroseeding, landscaping, and/or soil stabilizers. Additionally, proposed landscaping along the hillside and slope areas would help to prevent erosion. The Project Contractor will be required to submit a Storm Water Pollution Prevention Plan (SWPPP), which includes erosion control measures in order to comply with the National Pollution Discharge Elimination System (NPDES) requirements of the Federal Clean Water Act (CWA). Implementation of Mitigation Measures 5.9-1a through 5.9-1c in Section 5.9, HYDROLOGY AND WATER QUALITY, would reduce the potential erosion impacts to less than significant levels.

FAULT RUPTURE

5.10-2 *Implementation of the proposed alignment has the potential to expose commuters to adverse effects associated with rupture of a known earthquake fault.* ***Significance: Although Mitigation Measure 5.10-2 is recommended to reduce fault rupture impacts, significant and unavoidable impacts would result in this regard.***

Impact Discussion: As with most areas within southern California, the proposed roadway alignment is located in a seismically active region, and thus ground shaking would be likely to occur. These hazards are related to the principal active faults within the region of the Project site, and include the Whittier-Elsinore, Chino, San Andreas, San Jacinto, and Newport-Inglewood Faults. Two of the faults, the

Whittier-Elsinore and Chino Fault, are identified as Alquist-Priolo Earthquake Fault Zones. Active faults that are part of the Whittier-Elsinore and Chino Fault Zones traverse the Project site. The southern two-thirds of the proposed alignment lie within these zones. The City's *General Plan* provides goals and policies for the potential geotechnical hazards within the City of Corona (refer to the City's *General Plan* Policies 11.1.2 and 11.1.5 identified above). The goals and policies were established to ensure that development satisfactorily addresses the proper siting, design, and construction of "essential facilities", including their continued functioning in the event of a seismic or other geologic disaster. The proposed Project is required to comply with the UBC, State, County, and City regulations related to seismic hazards. Follow-up field studies during PS&E would confirm that the Project design meets these seismic safety standards, or would recommend engineering techniques to ensure compliance with the most current engineering standards for seismic design. However, due to the fact that the proposed roadway alignment is an essential facility and active faults traverse the Project site, the proposed Project would not be consistent with the City's *General Plan* Policy 11.1.2. The proposed alignment will be designed to minimize seismic impacts. Nonetheless, development of the proposed alignment with adequate setbacks to avoid fault rupture impacts may not be possible, as active faults traverse the Project site. Although Mitigation Measure 5.10-2 is recommended to reduce fault rupture impacts, significant and unavoidable impacts would occur in this regard.

SEISMIC GROUND SHAKING

5.10-3 *Implementation of the proposed alignment may increase the number of people exposed to effects associated with seismically induced ground shaking.* ***Significance: Compliance with the Uniform Building Code, State, County, and City regulations related to seismic ground shaking would reduce this potential impact to less than significant levels. Recommended Mitigation Measures 5.10-3a and 5.10-3b are required to ensure compliance with these regulations.***

Impact Discussion: Given the highly seismic character of the area, moderate to severe ground shaking associated with earthquakes on the nearby faults and the faults located on-site can be expected within all parts of the City. As mentioned above, two active faults traverse the Project site. Therefore, ground shaking is likely on the Project site in the event of a major earthquake from any one of the faults. Local commuters may be exposed to seismic ground shaking if it occurs during the short period of time that they drive on the proposed roadway alignment. The proposed alignment would be designed and constructed to withstand the magnitude of an earthquake of the surrounding faults. Based on predicted maximum peak ground accelerations at the site (refer to Table 5.10-1 above) and given the soil types identified in the *Geotechnical Study*, ground failure could occur at the Project site. The proposed Project is required to comply with the UBC, State, County, and City regulations related to seismic ground shaking. Follow-up field studies during PS&E would confirm that the Project design meets these seismic safety standards, or would recommend engineering techniques to ensure compliance with regulations. The follow up geotechnical report will evaluate potential stability impacts related to seismic ground shaking and recommend mitigation as necessary (refer to Mitigation Measure 5.10-3a). The proposed soil nail wall will be designed considering the seismic conditions. The design of the proposed alignment may include longer nails,

and smaller horizontal and vertical spacing of the nails. Stabilization fills or buttress fills may be required in front of cut slopes to limit slope displacement due to large earthquake events. However, specific engineering recommendations related to seismic ground shaking shall be identified in the required follow up geotechnical report (refer to Mitigation Measure 5.10-3a). Compliance with the UBC, State, County, and City regulations related to seismic ground shaking would reduce this potential impact to less than significant levels. Implementation of Mitigation Measures 5.10-3a and 5.10-3b would ensure the proposed alignment is designed to meet these regulations.

LIQUEFACTION

5.10-4 *Implementation of the proposed alignment may increase the number of people subject to substantial adverse effects associated with liquefaction.* ***Significance: Compliance with the Uniform Building Code, State, County, and City regulations related to liquefaction would reduce this potential impact to less than significant levels. Recommended Mitigation Measures 5.10-4a and 5.10-4b are required to ensure compliance with these regulations.***

Impact Discussion: The Project site traverses a number of large, alluvial-filled canyons including the Wardlow, Mabey, and Hagador Canyons. Additionally, young and old alluvial fan deposits underlie the south portion of the proposed alignment as it enters the Corona Plain. Since alluvial sediments commonly have an unconsolidated nature and can experience shallow groundwater conditions, the potential for liquefaction is possible within these areas.

The proposed Project is required to comply with the UBC, State, County, and City regulations related to liquefaction. Structures founded on shallow foundations are designed to accommodate settlement or movement. Structures founded on deep foundations (piles) are designed to carry additional loads due to liquefaction. Slopes can potentially experience varying magnitudes of vertical and lateral deformation. Follow-up field studies during PS&E would confirm that the Project design meets these seismic safety standards, or would recommend engineering techniques to ensure compliance with regulations. In general, there are various types of ground improvement methods that may be utilized to mitigate the adverse impacts of soil liquefaction. Ground improvement methods may include the following:

(a) For near-surface liquefiable soils, the existing near-surface liquefiable soils could be overexcavated and recompacted to a higher relative density.

(b) For liquefiable soils that are present at depth (that cannot be removed by overexcavation), the liquefiable soils can be densified by installing stone columns, installing Deep Soil Mix (DSM) columns, using Deep Dynamic Compaction (DDM), or compaction grouting.

However, specific recommendations to minimize impacts related to liquefaction shall be determined in a site-specific geotechnical report prepared by a registered geologist or soils engineer, prior to the issuance of a grading permit (refer to Mitigation Measure 5.10-4a). All recommendations in the geotechnical report shall

be implemented during site preparation, grading, and construction of the proposed alignment. Additionally, the proposed alignment must comply with the UBC regulations related to liquefaction. Development of the proposed alignment in conformance with established construction and design parameters set forth in the UBC would reduce potential liquefaction impacts to a permissible level. Prior to the approval of final Project plans and specifications, the City Engineer, or his designee, shall confirm that the plans and specifications illustrate the proposed alignment complies with UBC and the most current engineering standards related design for development on liquefiable soils (refer to Mitigation Measure 5.10-4b). Compliance with the UBC, State, County, and City regulations related to liquefaction would reduce this potential impact to less than significant levels. Recommended Mitigation Measures 5.10-4a and 5.10-4b are required to ensure compliance with these regulations.

LANDSLIDES

5.10-5 *Implementation of the proposed alignment has a low potential of exposing people to seismically induced landslides.* ***Significance: Less than significant impacts are anticipated.***

Impact Discussion: According to the *Geotechnical Study*, no existing landslides have been mapped along the alignment of the Project site. However, the potential for heavily sheared and fractured material should be considered due to the proximity of the alignment of the Whittier-Elsinore Fault Zone. If left untreated, areas of weak materials would have the potential to be subject to movement triggered by strong seismic shaking and, therefore, adverse conditions could occur. However, during the design phase of the proposed alignment, areas that are found to contain weak materials would be investigated and thus, remedial grading options would be developed to stabilize materials that are susceptible to seismic landslide movement. Therefore, the potential for seismically induced landslides is less than significant.

SUBSIDENCE/EXPANSIVE SOILS/SLOPE STABILITY

5.10-6 *The proposed alignment could potentially expose commuters or roadways to soil expansion and slope stability as a result of on-site slope/soil stability characteristics.* ***Significance: Compliance with the Uniform Building Code and implementation of recommended Mitigation Measures 5.10-6a through 5.10-6d would reduce this potential impact to a less than significant level.***

Impact Discussion: As previously discussed above, there are no known ongoing or planned large-scale extractions of groundwater, gas, oil, or geothermal energy that would cause subsidence in the Project area. Therefore, there is no known hazard related to land subsidence within the Project area.

Construction of the proposed alignment would include man-made fill, trench-walls, and cut and fill slopes. According to the *Geotechnical Study*, bedrock underlies the Project site and is considered only slightly compressible. Therefore, it is expected to adequately support embankment fills and roadway loads. Man-made fill and alluvium along the alignment are typically compressible and may be collapsible; as a result,

these materials may not be suitable for the support of fills and structural loads in its natural state. During the final design phase and the construction of the proposed alignment, soils with the potential to collapse or expand will be identified, evaluated, and mitigated (refer to Mitigation Measure 5.10-6d). Therefore, the potential damage related to expansive soils is less than significant.

All cut and fill slopes that are proposed along the Foothill Parkway extension would incorporate standard practices of the UBC during the design phase and construction to identify any unstable conditions. If any unstable conditions were found on-site, the Project Contractor would suggest recommendations for the final design phase of the Project. Also, the Project Contractor would suggest recommendations regarding trench-wall stability, which would be provided during the design phase of the proposed roadway alignment (Mitigation Measures 5.10-6a through 5.10-6d). Therefore, impacts associated with unstable slopes and trench-wall stability would result in less than significant impacts.

CUMULATIVE IMPACTS

Threshold: Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death 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
- Strong seismic ground shaking
- Seismic-related ground failure, including liquefaction
- Landslides

The Glen Ivy Fault, part of the Elsinore Fault, is located in the southwestern portion of the City and is designated as an Alquist-Priolo Earthquake Fault Zone. The Whittier Fault and the Chino-Central Avenue Fault are located within five miles of the City. The City's *General Plan* includes policies to minimize the risk of injury, loss of life, and property damage from an earthquake. Any development within 1/8 mile of an Alquist-Priolo Fault Zone is required to conduct a site-specific geotechnical report. Compliance with the UBC, State, County, and City regulations related to seismic hazards would reduce overall cumulative impacts of earthquakes to less than significant.

Two active faults traverse the Project site. Therefore, local commuters may be exposed to seismic ground shaking if it occurs during the short period of time that they drive on the proposed roadway alignment. The proposed alignment would be designed and constructed to withstand seismic ground shaking. The proposed alignment will be designed to minimize seismic impacts. Compliance with the UBC, State, County, and City regulations related to seismic hazards would reduce impacts to less than significant in this regard. However, development of the proposed alignment would result in significant unavoidable impacts related to fault rupture. Therefore, the proposed Project would result in an incremental increase to cumulative impacts with regards to fault rupture.

Level of Significance Before Mitigation –

Overall Cumulative Impact: Potentially Significant Impact.

Project Cumulative Contribution: Potentially Significant Impact.

Level of Significance After Mitigation –

Overall Cumulative Impact: Less Than Significant Impact.

Project Cumulative Contribution: Significant and Unavoidable Impact.

Mitigation Measures: 5.9-1 through 5.9-6.

Threshold: Be located on a geologic unit or soil that is unstable, or that would become unstable and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction, or collapse.

Areas of the City are subject to subsidence, landslides, and liquefaction. Prior to development, projects would be required to conduct a site-specific geotechnical study to determine the potential for unstable geologic units and soils. Additionally, development projects would be required to comply with the UBC, State, County and City regulations. Upon compliance with these regulations, and any site-specific mitigation measures, overall cumulative impacts would be less than significant.

The *Geotechnical Study* for the proposed Project concluded that the liquefaction potential of unconsolidated alluvial deposits shall be defined during final design, no existing landslides have been mapped along the alignment of the Project site, and there are no known ongoing or planned large-scale extractions that would cause subsidence in the Project area. However, the Project shall conform with applicable City criteria, adhere to standard engineering practices, and incorporate standard practices of the UBC during the design phase and construction. Additionally, the *Geotechnical Study* recommended mitigation measures to minimize impacts. Therefore, the project would not contribute to cumulative impacts.

Level of Significance Before Mitigation –

Overall Cumulative Impact: Potentially Significant Impact.

Project Cumulative Contribution: Potentially Significant Impact.

Level of Significance After Mitigation –

Overall Cumulative Impact: Less Than Significant Impact.

Project Cumulative Contribution: Less Than Significant Impact.

Mitigation Measures: 5.10-1 through 5.10-6d.

5.10.5 MITIGATION MEASURES

The following mitigation measures directly correspond to the identified Impact Statements in the Impacts discussion.

SOILS

5.10-1 Refer to Mitigation Measures 5.9-1a through 5.9-1c in Section 5.9, HYDROLOGY AND WATER QUALITY.

FAULT RUPTURE

5.10-2 Prior to the approval of final Project plans and specifications, the City Engineer, or his designee, shall confirm that the plans and specifications illustrate the proposed alignment complies with Uniform Building Code and the most current engineering standards related to design and siting for seismic hazards.

SEISMIC GROUND SHAKING

5.10-3a Prior to the issuance of a grading permit, a site-specific geotechnical report shall be prepared by a registered geologist or soils engineer and submitted to the City Engineer, or his designee, for approval. The geotechnical report shall provide construction recommendations to minimize impacts related to seismic ground shaking. All recommendations in the geotechnical report shall be implemented during site preparation, grading, and construction.

5.10-3b Prior to the approval of final Project plans and specifications, the City Engineer, or his designee, shall confirm that the plans and specifications illustrate the proposed alignment complies with Uniform Building Code and the most current engineering standards related seismic ground shaking.

LIQUEFACTION

5.10-4a Prior to the issuance of a grading permit, a site-specific geotechnical report shall be prepared by a registered geologist or soils engineer and submitted to the City Engineer, or his designee, for approval. The geotechnical report shall provide construction recommendations to minimize impacts related to liquefaction. All recommendations in the geotechnical report shall be implemented during site preparation, grading, and construction.

5.10-4b Prior to the approval of final Project plans and specifications, the City Engineer, or his designee, shall confirm that the plans and specifications illustrate the proposed alignment complies with Uniform Building Code and the most current engineering standards related design for development on liquefiable soils.

LANDSLIDES

5.10-5 No mitigation measures are required.

EXPANSIVE SOILS/SLOPE STABILITY

5.10-6a Cut slopes which expose loose sands and gravels shall be required to include over excavation and replacement with a drained stabilization fill.

5.10-6b Fill slopes shall be designed at a two to one ratio (or flatter), in a horizontal to vertical direction. Locally steeper fill slopes shall be considered but shall be constructed with geosynthetics to enhance the shear strength of fill materials. Higher compaction standards, which are typically 93 percent of the laboratory maximum dry density, should be implemented in deeper fills of greater than 40 feet to enhance engineering characteristics and reduce the amount of potential settlement. Subsurface drainage devices shall be installed below fills to intercept and direct water that may seep from the bedrock or be introduced from the surface.

5.10-6c Natural slopes that expose loose sands and gravels shall require and include over excavation and replacement with a drained stabilization fill/shear key.

5.10-6d To ensure stability of expansive soils, the following techniques shall be followed: proper design of foundations, slabs, streets and other improvements subject to the influence of soils; over excavation of the expansive soils and replacement with less expansive fill soils; utilizing selective grading techniques to place more highly expansive soils well below foundation elements; employment of presaturation techniques to lessen expansion potential; control of surface and subsurface drainages to prevent moisture variations; and combinations of these various techniques.

CUMULATIVE IMPACTS

Refer to Mitigation Measures 5.10-1 through 5.10-4b, and 5.10-6a through 5.10-6d.

5.10.6 LEVEL OF SIGNIFICANCE AFTER MITIGATION

Geologic and seismic hazards, related to soil erosion, ground shaking, liquefaction, landslides, and expansive soils/soil stability, associated with implementation of the proposed alignment would be less than significant with compliance with the UBC, State, County, and City regulations, and implementation of recommended Mitigation Measures 5.10-1 through 5.10-4b, and 5.10-6a through 5.10-6d.

Although implementation of Mitigation Measure 5.10-2 would reduce fault rupture impacts, it may not be possible to fully mitigate fault rupture impacts. Therefore, significant and unavoidable impacts would occur in this regard. As such, the proposed Project would also cumulatively contribute to fault rupture impacts.

If the City of Corona approves the Foothill Parkway Westerly Extension Project, the City shall be required to adopt findings in accordance with Section 15091 of the CEQA Guidelines and prepare a Statement of Overriding Considerations in accordance with Section 15093 of the CEQA Guidelines.

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