

3.11 Geology/Soils/Seismic/Topography

The information in this section is based on the *Preliminary Geotechnical Design Report* (Kleinfelder, 2008.)

3.11.1 Regulatory Setting

For geologic and topographic features, the key federal law is the Historic Sites Act of 1935, which establishes a national registry of natural landmarks and protects “outstanding examples of major geological features.” Topographic and geologic features are also protected under the California Environmental Quality Act.

This section also discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. The Department’s Office of Earthquake Engineering is responsible for assessing the seismic hazard for Department projects. The current policy is to use the anticipated Maximum Credible Earthquake (MCE), from young faults in and near California. The MCE is defined as the largest earthquake that can be expected to occur on a fault over a particular period of time.

The Alquist-Priolo Earthquake Fault Zoning Act was passed by the State of California in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act’s main purpose is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Seismic Hazards Mapping Act, passed in 1990, addresses nonsurface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.

The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones¹) around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities and counties and state agencies for their use in planning and controlling new or renewed construction.

¹ “Earthquake Fault Zones” were called “Special Studies Zones” prior to January 1, 1994.

3.11.2 Affected Environment

California comprises 11 geomorphic provinces as defined by the California Department of Mining. The MCP study area is located within the Peninsular Ranges Geomorphic Province. The Peninsular Range province is a series of mountain ranges separated by northwest-trending valleys running parallel to faults branching from the San Andreas fault. The Peninsular Ranges extend south to Mexico and are bordered by the Transverse Ranges on the north, the Colorado Desert on the east, and the Pacific Ocean on the west.

3.11.2.1 Local Geology/Topography

There are no designated National Natural Landmarks within the MCP study area.

As shown in Figure 3.11.1, the far western portion of the MCP study area is located within the northwest-trending Temescal Valley, bounded by the Santa Ana Mountains on the west and the east by the Perris Block (a structural geologic block bounded by faults and fault systems).

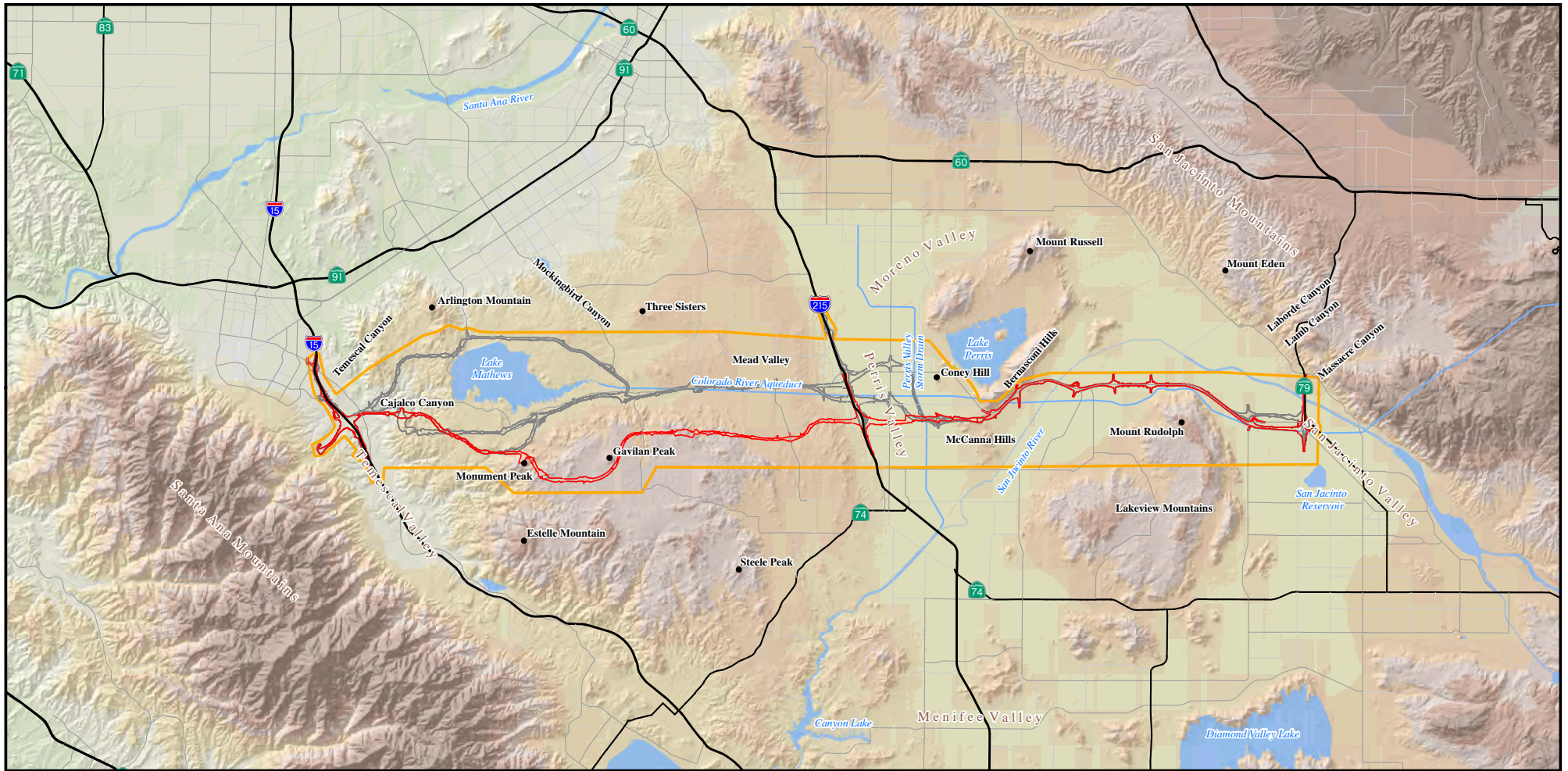
Natural landmarks help define the topography of the MCP study area, which ranges from moderately rugged to gently rolling hills in the west, transitioning to flat, open, ruderal and agricultural lands in the east.

The most distinct landmarks within the western portion of the MCP study area include Monument Peak and Gavilan Peak, part of the Gavilan Hills. Monument Peak is 744 meters (m) (2,442 feet [ft]) above sea level, while Gavilan Peak, which is about 5 kilometers (km) (3 miles [mi]) east of Monument Peak, is 711 m (2,333 ft) above sea level.

Continuing east in the MCP study area, the Bernasconi Hills are a distinct natural landmark of the Lake Perris area. Trending northeast and located approximately 9 km (6 mi) northeast of Perris, the elevation of the Bernasconi Hills is approximately 808 m (2,647 ft) above sea level.

The McCanna Hills lie south of Lake Perris, directly south of the Ramona Expressway. These are relatively low lying hills with an elevation of approximately 518 m (1,700 ft) above sea level.

The northern portion of the Lakeview Mountains is one of the most distinctive landmarks in the eastern MCP study area. Mount Rudolph, a prominent feature at the northerly end of the range, rises to an elevation of 791 m (2,595 ft) above sea level.



- Legend
- Study Area
 - Right-of-Way (Alternative 9)
 - Right-of-Way (Alternatives 4,5,6 and 7)



SOURCE: USGS (2006), Jacobs Engineering (2/2007), TBM (2007)



F:\JCV531\GIS_Final\EIR_EIS\20080402_EIR_EIS_Final\Landforms_TopographicFeatures_100807.mxd (8/6/2008)

Figure 3.11.1



This page intentionally left blank

The topography from Temescal Valley eastward to Lake Mathews is characterized as mountainous terrain with moderately rugged slopes and well-cut drainage channels. Lake Mathews is a man-made lake formed by damming a naturally occurring valley at the head of Cajalco Canyon. The area surrounding the lake is an irregular plateau with gently rolling hills and tributary channels.

The area just east of Lake Mathews and on the western side of Perris Valley is characterized by moderate relief and gently rolling hills. Mead Valley is located in this area, separated from the Perris Valley by low hills along the eastern margin.

Perris Valley is a 6 to 8 km (4 to 5 mi) wide, alluvial-filled basin that extends from Moreno Valley on the north to Menifee Valley on the south. The Bernasconi Hills define the eastern border of the Perris Valley, separating it from the San Jacinto Valley.

The San Jacinto River floodplain is located within a northeast-trending valley between Perris Valley and the San Jacinto Valley, bordered by the Bernasconi Hills on the west and the Lakeview Mountains on the southeast. The San Jacinto River flows toward the Elsinore Valley approximately 32 km (20 mi) to the southwest.

The eastern end of the MCP study area is within the San Jacinto Valley. The San Jacinto Valley is an alluvial valley along the San Jacinto fault zone.

3.11.2.2 Faulting/Seismicity

The entire southern California region is seismically active due to the influence of several earthquake fault systems resulting from interaction between the Pacific and North American crustal plates. An active fault is defined by the State of California as a “sufficiently active and well defined fault that has exhibited surface displacement within the last 11,000 years.” A potentially active fault is defined by the State as a “fault with a history of movement between 11,000 and 1.6 mya” (million years ago). These active and potentially active faults are capable of producing seismic shaking within the MCP study area that could be damaging to bridges and other structures. Figure 3.11.2 illustrates the major fault zones in the MCP study area.

This page intentionally left blank

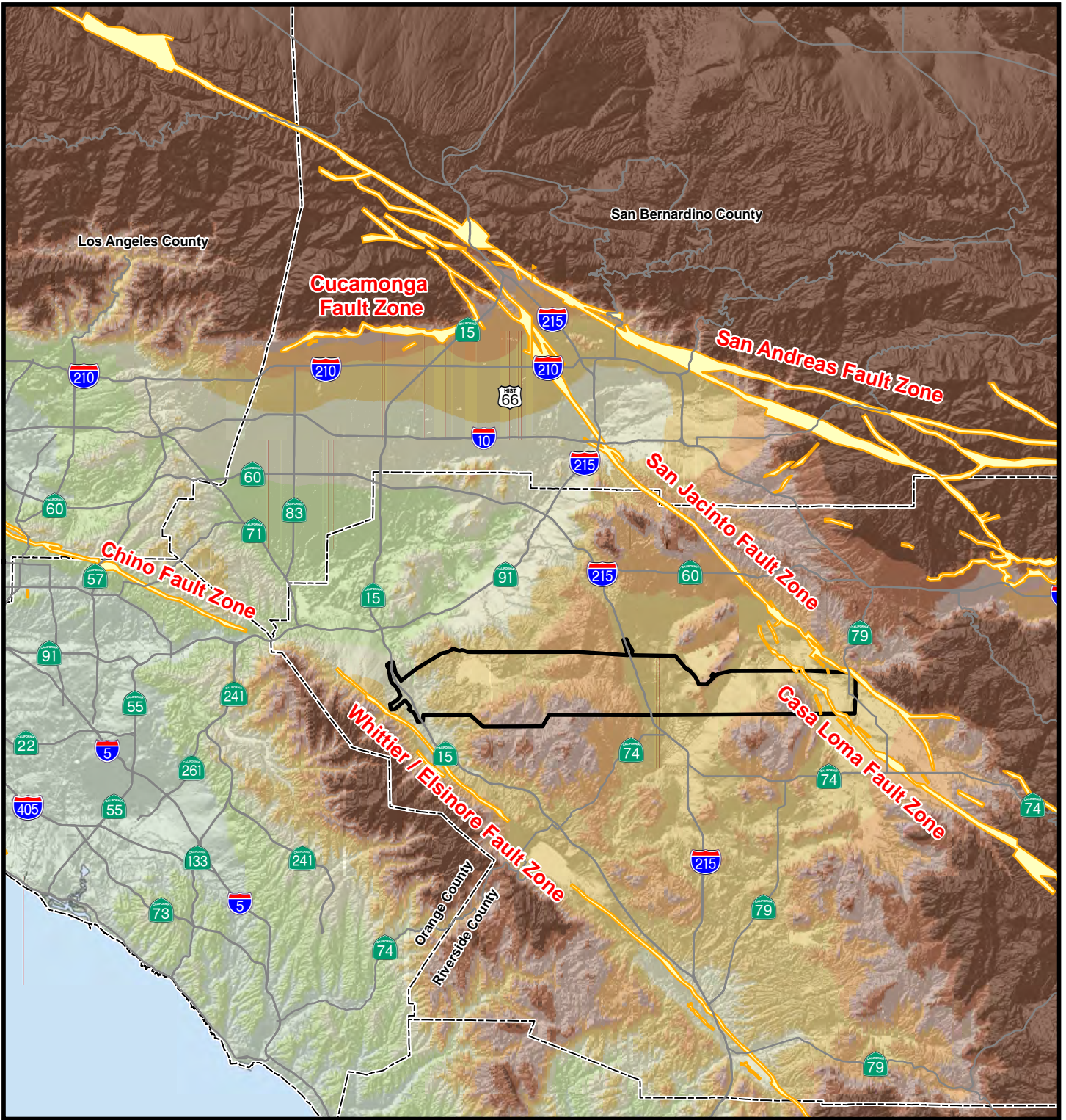





Figure 3.11.2

Legend

-  Fault Zone
-  Mid County Parkway Study Area
-  County Boundary

SOURCE: California Department of Conservation (1997), ESRI (2006), Jacobs Engineering (2/2007), LSA (2007)



Fault Zones

KP 0.0/51.0 (PM 0.0/31.7) EA 08-0F3200



This page intentionally left blank

There are several major active fault zones capable of generating ground shaking during a seismic event which could impact the MCP study area: the San Jacinto fault zone (which includes the Casa Loma fault), located near the eastern end of the MCP study area; and the Whittier/Elsinore fault zone, located near the western end of the MCP study area. Other faults capable of generating ground shaking that would affect the MCP study area include the San Andreas, Chino, and Cucamonga faults. Table 3.11.A summarizes the five major active faults that could impact the MCP study area.

Table 3.11.A Active Faults in the Mid County Parkway Study Area

Fault/Fault Zone	Distance from Site – East End, mi (km)	Distance from Site – West End, mi (km)	Maximum Moment Magnitude (Mw)	Maximum Historic Earthquake Magnitude (Mw) with year	Probability of Occurrence in 100 years
San Jacinto/ Casa Loma	0.2 (0.3) – 19.0 (30.6)	20.8 (33.4)	6.75	7.0 (1918)	High
San Andreas	15.1 (24.3)	29.2 (47.0)	7.75	8.0+ (1857)	High
Whittier-Elsinore	23.2 (37.4)	2.8 (4.5)	7.5	6.0 (1910)	Moderate-High
Chino	32.4 (52.1)	2.9 (4.7)	6.5	Unknown	Unknown
Cucamonga	35.2 (56.6)	24.2 (38.9)	7.0	5.2 (1990)	High

Source: *Preliminary Geotechnical Design Report*, Kleinfelder, 2008.
 km = kilometers
 mi = miles

The San Jacinto fault zone extends from the Cajon Pass north of San Bernardino trending southeast to the California-Mexico border and beyond. Near the east end of the MCP study area, the San Jacinto fault consists of a number of fault segments and numerous fissures associated with crustal movement. The Casa Loma fault, a segment of the San Jacinto fault zone, crosses the eastern portion of the MCP study area. The Casa Loma fault was exposed in an aqueduct excavation southeast of the intersection of Warren Road and Ramona Expressway, and is considered active by the State of California. The fault is also included within the Alquist-Priolo Earthquake fault zone.

The Elsinore fault is located approximately 2.4 km (1.5 mi) southwest of the existing I-15/Cajalco Road interchange. The Elsinore fault is one of the largest in southern California, and historically has been one of the quietest. This fault is part of the greater Whittier-Elsinore fault system that extends from the Los Angeles Basin, south to the California/Mexico border and beyond. In the MCP study area, this fault zone is a series of northwest-trending faults forming the boundary between the Santa Ana Mountains on the west and Temescal Valley on the east.

3.11.2.3 Landslides

Landslides constitute a major geologic hazard because they are widespread and cause substantial damage to life and property. Expansion of urban and recreational developments into hillside areas leads to more people that are threatened by landslides each year. Landslides commonly occur in connection with other major natural disasters such as earthquakes, volcanoes, wildfires, and floods. Steep, bare slopes; clay-rich rock; deposits of stream or river sediment; and heavy rains can also cause landslides.

The average annual precipitation in the MCP study area is low, about 26.6 centimeters (cm) (10.5 inches [in]) annually. Natural slopes susceptible to instability occur primarily in the mountainous western half of the MCP study area and within the Bernasconi Hills. No known landslides have been mapped along or adjacent to the proposed MCP Build Alternatives in the MCP study area. The primary stability issue for bedrock slopes in the MCP study area is the possibility of rock fall on steep slopes. While the bedrock is generally steeply inclined, it is favorable for overall stability. However, existing slopes and future cut slopes may be subject to toppling, rock fall, and localized instability along fractures in the bedrock. Existing slopes underlain by older stream deposition and sedimentary bedrock are also subject to erosion and instability.

3.11.2.4 Liquefaction

Soil liquefaction occurs when saturated, loose soils lose their strength due to excess water within the soils. The space between the soil particles is completely filled with water, which exerts pressure on the soil particles, influencing how tightly the soil particles are pressed together. Prior to an earthquake, the water pressure is relatively low. However, the shaking caused by an earthquake can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other. When liquefaction occurs, the strength of the soil decreases and the ability of the soil to support building and bridge foundations are reduced. Liquefied soils also exert pressure on retaining walls, which can cause them to tilt or slide.

The primary factors affecting the possibility of liquefaction in a soil deposit are: (1) intensity and duration of earthquake shaking, (2) soil type and relative density, (3) overburden pressures, and (4) depth to groundwater. Soils most susceptible to liquefaction are clean, loose, uniformly graded, fine-grained sands, and nonplastic silts that are saturated. Silty sands have also been proven susceptible to liquefaction.

The presence and depth of groundwater in an area will determine if the land is more or less subject to liquefaction (the state of becoming liquid) and instability. Groundwater conditions are variable within the MCP study area and are divided into three distinct regions.

Temescal Valley

Groundwater within Temescal Valley has been reported as shallow as 1.5 m (5 ft) in 1992 in wells 152 m (500 ft) north of Cajalco Road at Temescal Wash. Shallow groundwater is also anticipated within Bedford Wash near the I-15 interchange, although the Log of Test Borings for the Bedford Wash Bridge did not report groundwater to depths of 17 m (55 ft) in borings drilled in 1964. Borings drilled in this area in 2006 encountered groundwater at a depth of 7 m (23 ft) below the existing ground surface. This depth approximately correlates with groundwater conditions associated with Temescal Wash.

Mead Valley and Lake Mathews Area

Much of the Mead Valley and Lake Mathews area is underlain by nonwater-bearing granitic and metamorphic bedrock. Groundwater in these areas generally occurs as water perched above the bedrock and within shallow alluvial filled valleys and drainage channels. Perched groundwater has been reported as shallow as 1 m (3 ft) below the ground surface along portions of Cajalco Road near Wood Road. Two borings drilled in this area in 2006 encountered groundwater at depths of 3.4 m (11 ft) and 5 m (16 ft), respectively, below existing ground surface. These depths are consistent with anticipated shallow groundwater depths within Mead Valley.

Perris and San Jacinto Valleys

Groundwater in the eastern half of the MCP study area generally occurs within three groundwater subbasins referred to as the Perris South, Lakeview, and San Jacinto subbasins.

The Perris South subbasin is located within Perris Valley between I-215 on the west and the Bernasconi Hills on the east. The average depth to groundwater within this subbasin ranged from approximately 19 m (61 ft) to 18 m (58 ft). Well records reviewed indicate groundwater is shallowest near the mouth of the Lake Perris dam and was recorded as shallow as 6 m (20 ft). Seepage from Lake Perris may be contributing to the shallow groundwater in this area. The depth to groundwater increases to the west and was on the order of 31 to 40 m (102 to 136 ft) deep near the middle of the valley.

Three borings drilled in 2006 within the Perris subbasin along Placentia Avenue and Rider Street and adjacent to the Perris Valley Storm Drain in 2006 encountered groundwater at depths of 14, 11, and 15 m (46, 35, and 48 ft), respectively, below the existing ground surface.

The Lakeview subbasin is located within the San Jacinto River Valley between Perris Reservoir and the Lakeview Mountains. The average depth to groundwater within this subbasin ranged from approximately 65 to 67 m (214 to 220 ft). Individual well records near the community of Lakeview and the San Jacinto River indicate a depth to groundwater ranging from approximately 55 to 76 m (182 to 248 ft).

The San Jacinto subbasin is located within the San Jacinto Valley at the eastern end of the MCP study area. The average depth to groundwater within this subbasin ranged from approximately 55 to 56 m (182 to 185 ft). Individual well records near the SR-79 interchange indicate a depth to groundwater of approximately 50 to 78 m (163 to 256 ft). Borings drilled in this area in 2006 encountered groundwater at a depth of 6 m (21 ft) near the intersection of Ramona Expressway and SR-79.

3.11.2.5 Soils

The entire MCP study area is located in a geologic environment that may be prone to collapsible soils. The potential for soils to collapse ranges from low to moderate for the majority of the alluvial soil deposits. The ability of these soils to expand when wet and shrink when dry (change volume) ranges from low to high, depending on the nature of the soils and underlying parent bedrock materials. Residual soils within the MCP study area may also be expansive.

Surface soils within the study area include artificial fill, colluvial soils, Holocene alluvium, Pleistocene older alluvium and fan deposits, Tertiary sandstone and siltstone, Mesozoic plutonic and volcanic rocks, and Mesozoic metamorphic rocks.

Artificial Fill

Artificial fill is associated with existing developments, such as roads and structures, and is present within the MCP study area. Fills are typically composed of materials derived from the surrounding terrain and, for engineering purposes, are generally required to meet certain specifications related to grain size, composition, and compaction.

Artificial fill can be found at the western end of the MCP study area near Cajalco Road and Temescal Canyon Road, and adjacent to Temescal Wash, to depths of

approximately 1.5 m (5 ft). Approximately 4.5 m (15 ft) of dump fill is located east of Elsinore Road. The fill materials generally consist of silty sands with gravel, sand with silt, and sandy gravel with local cobbles. The coarse-grained soils are generally loose to medium dense with occasional stiff, fine-grained layers.

Colluvium

Colluvium, a collection of loose rock debris at the base of a hill or slope, can be found around most of the hillsides and valley areas within the MCP study area. This colluvium (dating from approximately 10,000 years ago to the present) has a variable thickness depending upon the location within the MCP study area.

Younger Alluvium and Fan Deposits

Alluvium, deposits of sand and mud formed by flowing water, underlie much of the MCP study area, including Temescal and Bedford Washes, Mead Valley, Perris and San Jacinto Valleys, and the San Jacinto River floodplain. These relatively young (dating from approximately 10,000 years ago to the present), nonmarine deposits generally consist of fine- to coarse-grained sand with various amounts of silt, clay, and gravel. Cobbles and boulders are common near the base of the deposits.

Alluvium and fan deposits (fan-shaped accumulations of alluvium deposited at the mouth of a ravine or foot of a mountain) are located in the portions of the MCP study area with steeper topography, including the Santa Ana Mountains, the Gavilan Hills, and the Bernasconi Hills. These deposits consist of sands, silty sands, clayey sands, and sandy silts with occasional clay, gravel, and sandy gravel layers. These soils are medium dense to very dense, and the fine-grained layers are stiff to very stiff. Portions of the alluvial soils are likely subject to collapse and consolidation when wet.

Older Alluvial Deposits

Alluvial deposits, including fan deposits, dating from approximately 10,000 to 2 mya are located within Temescal Valley and Wash, on slopes south of Lake Mathews, within Perris Valley, and adjacent to the San Jacinto River floodplain. These older alluvial channel deposits also underlie the central portion of Mead Valley east of Lake Mathews. These older alluvium materials are similar in composition and origin to the younger alluvial deposits but are more consolidated. These soils are medium dense to very dense, and the fine-grained layers are stiff to very stiff.

3.11.3 Environmental Consequences

3.11.3.1 Permanent Impacts

Build Alternatives

The roadway, structures, slopes, and other features of the MCP Build Alternatives could be impacted by ground motion and liquefaction, and possibly ground rupture (deformation) to some degree. Design and construction of the proposed project to current highway and structure design standards would minimize the impact of these conditions to the MCP Build Alternatives.

The primary geologic and geotechnical constraints affecting the design and construction of any of the MCP Build Alternatives include:

- Moderate to high ground accelerations due to the presence of nearby active faults, including the Elsinore, San Jacinto, Casa Loma, and San Andreas faults.
- Fault rupture associated with the Casa Loma branch of the San Jacinto fault in the eastern portion of the MCP study area.
- Impacts to bridges or raised structures due to local shallow groundwater. Shallow groundwater has been identified within Temescal Wash in the western portion of the MCP study area, in the Mead Valley area, near the downstream foundation of Perris Reservoir, and locally near Perris Dam in the Perris Valley.
- Liquefaction and seismically induced settlement in areas of shallow groundwater and loose alluvial soils. Areas subject to liquefaction and seismically induced settlement include Temescal and Bedford Washes, the San Jacinto River and Valley areas, Perris Valley, and locally within Mead Valley.
- Possibility of flooding within Temescal and Bedford Washes, the San Jacinto River and Valley areas, Cajalco Creek, Perris Valley, and locally at or adjacent to drainage crossings.
- Slope stability in areas of steep natural terrain or proposed cut slopes.
- Erosion and surficial instability in hillside areas.
- Difficult bedrock excavation characteristics. Hard granitic and metamorphic bedrock is anticipated in the western portion of the MCP study area and in the Bernasconi Hills.
- Collapsible soils in younger alluvium, primarily in the eastern portion of the MCP study area (Perris Valley and San Jacinto River and Valley areas) and within Temescal Wash.

Faulting/Seismicity

The eastern portion of the MCP study area is located within a designated Earthquake Fault Rupture Hazard Zone for the Casa Loma fault, a branch fault of the San Jacinto fault zone. This fault is considered active and crosses the Ramona Expressway approximately 214 m (700 ft) east of Warren Road, a location that is common to all of the MCP Build Alternatives. The planned interchange at Ramona Expressway/Warren Road may lie near or within this fault zone.

The possibility of moderate to severe seismic shaking is the most considerable geologic hazard to the project. The MCP study area is located in a region of Southern California that is seismically active and under the influence of several fault systems that are considered to be active or potentially active. Table 3.11.A previously listed the fault systems capable of producing damaging seismic shaking in the MCP study area. The project facilities and structures elements would be designed consistent with applicable building and seismic codes. As a result, the Build Alternatives would be anticipated to accommodate the expected ground shaking in this area, with the likelihood for structural damage substantially reduced or avoided through seismic engineering design.

Landslides

Landslides are rock, earth, or debris flows on slopes due to gravity. They can occur on any terrain given the right conditions of soil, moisture, and angle of slope. Landform alterations may create erosional impacts to the existing terrain. The most extensive alterations would be from construction of cut and fill slopes associated with road realignments. Erosion and sedimentation impacts could occur due to project construction. These impacts and avoidance, minimization, and/or mitigation measures are discussed in Section 3.10 (Water Quality and Storm Water Runoff) and Section 3.14 (Air Quality).

The *Preliminary Geotechnical Design Report* (Kleinfelder, 2008) identified the primary areas where natural slope instability may occur that would need to be considered in the design of the project. They are along the western portion of the MCP study area and within the Bernasconi Hills. Although none of the alignment alternatives are located in areas where landslides or instability are known, design-level geotechnical investigations would address this issue in more detail.

Cut-and-Fill Slopes

Cut-and-fill slopes would be required to construct any of the MCP Build Alternatives. As described in Chapter 2, extensive use of bridges is proposed to reduce the amount of cut and fill slopes. The majority of the cut slopes are located along Alternative 9, in the Gavilan Hills area and near Monument Peak, located in the southernmost part of the MCP study area. The proposed cut slopes are generally located in hard granitic and metamorphic bedrock. Other than local areas of rock fall or surface instability, no landslides or other evidences of major bedrock instabilities were observed in the areas of the proposed cut slopes. Cut-and-fill slopes would also be required in the McCanna Hills area to accommodate Alternative 9, as well as the other MCP Build Alternatives since this location is common to all the MCP Build Alternatives.

Table 3.11.B shows the estimated cut and fill material for each alternative.

Table 3.11.B Cut-and-Fill Material by Alternative

Alternative	Quantity and Type of Earthwork (cubic meters)			
	Excavation	Fill	Imported Borrow	Disposal Off Site
4	10,246,200	16,711,070	6,464,870	0
5	10,309,279	16,504,893	6,195,614	0
6	10,171,760	16,992,885	6,821,125	0
7	10,234,839	16,786,708	6,551,869	0
9	23,473,805	19,241,157	0	4,232,648

Source: Jacobs, 2008.

More extensive landform alteration also occurs under Alternative 9 due to its alignment through the Gavilan Hills and the area south of Lake Mathews near Monument Peak.

Due to the hardness of the bedrock in the Gavilan Hills, Monument Peak, and McCanna Hills areas, blasting may be required during construction activities of the cut-and-fill slopes. The entire process of an individual blast event to remove hard rock (excavation, drilling holes in the hard rock, placing charges and detonation cords, detonation at specific time intervals, removal of pulverized rock) can range in length from several days to several weeks, depending on the size of the area planned for each blast event. Typical blast events “pulverize” from approximately 6,116–30,582 cubic meters (m³) (8,000–40,000 cubic yards

[cy]) of in-place rock. The drilling contractor generally utilizes 7 or 10 cm (3 or 4 in) diameter holes and spaces the drill holes in a 3 x 3 m (9 x 9 ft) grid pattern. Depending on the project grade requirements, each blasting detonation can vary in depth from 3–12 m (10–40 ft). While the individual blast events would vary in size and depth depending on the final results desired by the blast event, a blast size of approximately 6,880 m³ (9,000 cy) of in-place rock would require approximately 9,525 kilograms (kg) (21,000 pounds [lbs]) of ammonium nitrate fuel oil.

To minimize the possibility of damage at or adjacent to the project site, test shots would be performed to determine hole depth, charge size, and depth of charge burial. These small charges would help reveal natural fractures in the rock that can create rock fragments, which are propelled through the air by the force of the blast and could endanger humans and nearby structures or equipment. The test shots would also monitor noise vibrations due to blasting. The test blasts would allow the blast contractor to minimize the possibility of damage at, or adjacent to, the proposed project site. Avoidance, minimization, and/or mitigation measures related to construction activities are provided in Sections 3.14, Air Quality, and 3.15, Noise.

Liquefaction

The MCP *Preliminary Geotechnical Design Report* (Kleinfelder, 2008) indicates a possibility for liquefaction along the proposed alternatives in areas of shallow groundwater and loose granular soils. Areas that may be prone to liquefaction include Temescal and Bedford Washes (all alternatives), the San Jacinto River and Valley areas (all alternatives), Perris Valley (all alternatives), and Mead Valley (Alternatives 4 through 7).

Impacts to the facilities and structures under the Build Alternatives due to liquefaction and seismically induced settlement can be substantially reduced based on design and construction, consistent with the recommendations of the detailed geotechnical investigations prepared during final design. As noted earlier, detailed site-specific geotechnical investigations would be conducted during final design to evaluate the possibility of liquefaction and seismically induced settlement along the alignments of the MCP Build Alternatives, and to provide recommendations for remediation if required.

Soils

Landform alteration throughout the MCP study area would likely occur due to construction grading. Erosion and sedimentation impacts could occur due to project construction. These impacts are discussed in Section 3.10 (Water Quality and Storm Water Runoff).

The primary areas where natural slope instability may occur that may influence project design are along the western portion of the MCP study area, and within the Bernasconi Hills. Deeper fills are anticipated within the embankments associated with the I-15 and the I-215 freeways, Temescal Wash, and locally along the proposed alignment alternatives. Embankment fill slopes constructed at an inclination of 1:2 (horizontal:vertical) or less, like the fill slopes planned as part of the project, should have adequate stability during a major seismic event and not be subject to failure or landslides. Therefore, the MCP Build Alternatives would not result in adverse impacts related to slope instability.

No Build Alternatives

Under the MCP No Build Alternatives, the permanent impacts discussed above for the MCP Build Alternatives would not occur for the MCP project itself, but earthquake and seismic safety concerns would be issues that would be analyzed as part of the environmental and engineering studies for the other transportation improvement projects included in the No Build Alternatives. The extensive grading and use of cut and fill slopes required for the MCP project would not occur under the No Build Alternatives.

Discussion of Impacts Relative to MSHCP Amendment

Geology/soils/seismic/topography was determined not to be a topic of concern and therefore was not analyzed in the Multiple Species Habitat Conservation Plan (MSHCP) EIR/EIS. An amendment to the MSHCP to provide coverage for Alternative 9 TWS DV (the Locally Preferred Alternative) would not change the conclusion of the MSHCP EIR/EIS related to geology, soils, seismic hazards, and topography.

3.11.3.2 Temporary Impacts

Build Alternatives

Temporary impacts are related to construction activities. Each of the Build Alternatives would alter existing landforms due to grading and construction of various cut and fill slopes. Construction activities may also temporarily disturb soil

outside the facility footprint, but within the project right of way, primarily in the trample zone around work areas, heavy equipment traffic areas, and material laydown areas. Temporary impacts would include soil compaction and increased possibility of soil erosion.

The construction activities associated with the proposed Build Alternatives could be impacted by ground motion and liquefaction, and possibly ground rupture (deformation) to some degree if an earthquake were to occur during construction. Implementation of safe construction practices and compliance with Caltrans and California Division of Occupational Safety and Health Administration (Cal-OSHA) requirements would minimize the impacts of these conditions.

No Build Alternatives

Under the MCP No Build Alternatives, the temporary impacts discussed above for the MCP Build Alternatives would not occur for the MCP project itself. Similar impacts would occur for the other transportation improvement projects included in the No Build Alternatives.

3.11.4 Avoidance, Minimization, and/or Mitigation Measures

While implementation of standard design and construction practices will reduce the MCP project's risk for geologic hazards such as soil erosion and slope instability, Mitigation Measures GEO-1 through GEO-4 listed below will also reduce potential impacts to liquefaction, soil, seismic issues, and erosion from implementation of the MCP project. The following measures would apply to all of the MCP Build Alternatives.

GEO-1 Prior to completion of final design, the Riverside County Transportation Commission (RCTC) will prepare a design-level geotechnical report. It is not feasible to prepare such a study at this time because the design is at a preliminary, conceptual stage. This report will document soil-related constraints and hazards such as slope instability, settlement, liquefaction, or related secondary seismic impacts that may be present. Acceptance of this report will be subject to the local agencies with jurisdiction over the MCP project right of way and the California Department of Transportation (Caltrans) for portions of the MCP project within State highway right of way. The performance standard for this report will be the geotechnical design

standards of the State of California, Caltrans, and the affected local jurisdictions. The report shall also include:

- Evaluation of expansive soils and recommendations regarding construction procedures and/or design criteria to minimize the effect of these soils on the development of the project.
- Identification of potential liquefiable areas within the project limits and recommendations for mitigation. Any areas that require mitigation would be within the disturbed areas, and no additional impacts would result.
- Demonstration that side slopes can be designed and graded so that surface erosion of the engineered fill is not increased compared to existing, natural conditions.

GEO-2 During construction, and as included on project plans during final design, the Riverside County Transportation Commission (RCTC) will require planting of native vegetation with good soil-binding characteristics and low water requirements on engineered slopes to reduce erosion and slope instability. These types of plants include species that are compatible with existing adjacent habitat and native to the project area, including but not limited to the following: brittlebush (*California encelia*), California buckwheat (*Eriogonum fasciculatum*), California sagebrush (*Artemisia californica*), and deerweed (*Lotus scoparius*). Sixty percent of the planting coverage shall be completed within the first 5 years of construction.

GEO-3 The Riverside County Transportation Commission (RCTC) will maintain a quality assurance/quality control plan during construction. The plan will include observing, monitoring, and testing by a geotechnical engineer and/or geologist during construction to confirm that geotechnical/geologic recommendations are fulfilled, or if different site conditions are encountered, appropriate changes are made to accommodate such issues. The geotechnical engineer will submit weekly reports to RCTC while grading, excavation, and construction activities are underway.

GEO-4 Prior to completion of final design, the Riverside County Transportation Commission (RCTC) will undertake a detailed review

of available well information to locate all groundwater wells within the MCP project right of way. Any groundwater wells that occur within the MCP project right of way will be identified on a well management plan and abandoned properly during project construction in accordance with California Department of Water Resources Standards (Bulletin 74-90). Any water supply provided by active wells will be replaced. Replacement water may be provided by a variety of means, such as installing a new well or by creating a connection to a municipal supply. The project engineer will document the location of existing wells, the abandonment approval by the agencies with jurisdiction for those wells within the MCP project right of way, and the replacement water supply as needed for active wells in a report submitted to RCTC for review and approval prior to initiation of construction activities.

This page intentionally left blank