



Section 5.8:

Geology and Seismic Hazards



5.8 GEOLOGY AND SEISMIC HAZARDS

This section describes the City of Murrieta's existing geologic, seismic, and soil conditions, and the existing Federal, State, and local regulations with which development must comply. Geologic and seismic impacts that could result from implementation of the proposed General Plan 2035 are identified. Information in this section is based upon the *Seismic and Geologic Hazards Review General Plan 2035, City of Murrieta, California* technical report prepared by Leighton and Associates, December 2009, and included as Appendix G.

5.8.1 REGULATORY SETTING

FEDERAL

Federal Soils and Water Resources Conservation Act

The purpose of the Federal Soil and Water Resources Conservation Act (1977) (*16 United States Code* Section 2001-2009) is to protect or restore the functions of the soil on a permanent sustainable basis. Protection and restoration activities include prevention of harmful soil changes, rehabilitation of the soil of contaminated sites and of water contaminated by such sites, and precautions against negative soil impacts. If impacts are made on the soil, disruptions of its natural functions and of its function as an archive of natural and cultural history should be avoided, as far as practicable. The Secretary of Agriculture oversees the programs associated with the Act.

STATE

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act (*California Public Resources Code*, Chapter 7.5, Section 2621-2699.6) was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This State law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. The 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, such as subsidence or liquefaction.



The Act requires the State Geologist to establish regulatory zones, known as “Earthquake Fault Zones,” around the surface traces of active faults and to issue appropriate maps. Earthquake Fault Zones were called “Special Studies Zones” prior to January 1, 1994. Local agencies must regulate most development projects within these zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. An evaluation and written report of a specific area must be prepared by a licensed geologist. If an active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault (typically 50 feet set backs are required).

Effective June 1, 1998, the Natural Hazards Disclosure Act requires that sellers of real property and their agents provide prospective buyers with a “Natural Hazard Disclosure Statement” when the property that is being sold lies within one or more State-mapped hazard areas, including Earthquake Fault Zones.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act (SHMA) of 1990 (*California Public Resources Code*, Chapter 7.8, Section 2690-2699.6) 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 SHMA 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. The SHMA specifies that the lead agency of a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

CALIFORNIA BUILDING STANDARDS CODE

California building standards are published in the *California Code of Regulations, Title 24*, known as the *California Building Standards Code (CBSC)*. The *CBSC* applies to all applications for residential building permits. The *CBSC* consists of 11 parts that contain administrative regulations for the California Building Standards Commission and for all State agencies that implement or enforce building standards. Local agencies must ensure that development complies with the guidelines contained in the *CBSC*. Cities and counties have the ability to adopt additional building standards beyond the *CBSC*. *CBSC* Part 2, named the *California Building Code* is based upon the *2009 International Building Code*, and Part 11, named the *California Green Building Standards Code*, and is also called the CalGreen Code.



California has adopted statewide, mandatory codes based upon the International Code Council's (ICC) Uniform codes. The 2010 California Building Standards Code will adopt the 2009 International codes (I-codes), and take effect January 1, 2011.

LOCAL

City of Murrieta Municipal Code

The "Building Code of the City of Murrieta" (*Building Code*) is codified in *Title 15, Buildings and Construction*, of the City's *Municipal Code*. The City's *Building Code* adopted the *California Building Code, 2010 Edition*. The purpose of the City's *Building Code* is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating the design, construction, quality of materials, use and occupancy, location and maintenance of buildings, equipment structures and grading within the City, the electrical, plumbing, heating, comfort cooling and certain other equipment specifically regulated herein; and the moving of buildings with, into, from and through the City.

Murrieta Emergency Operations Plan¹

The City of Murrieta Emergency Operations Plan (EOP) addresses the planned response to extraordinary emergency situations associated with natural disasters, national security emergencies, and technological incidents affecting the City. The EOP describes the operations of the City of Murrieta Emergency Operations Center (EOC), which is the central management entity responsible for directing and coordinating the various City departments and other agencies in their emergency response activities. The EOC centralizes the collection and dissemination of information about the emergency and makes policy-level decision about response priorities and the allocation of resources. As part of the City's Emergency Management Program, the EOC Manager (Fire Division Chief) is responsible for ensuring the readiness of the EOC.

The City has developed a set of quick response references (checklist) for the Murrieta EOC. The set checklist is located in Part Two of the City's Emergency Operation Plan. The checklist enumerates issues that are related to earthquake disasters and emergencies.

Riverside County Multi-Jurisdictional Local Hazard Mitigation Plan²

Table 6.6-2, Riverside County Local Jurisdiction Hazard Assessment Worksheet of Section 6.6, Emergency Response, provides a detailed identification and analysis of the hazards faced by Riverside County and the City of Murrieta according to the Riverside County Multi-Jurisdictional Local Hazard Mitigation Plan (LHMP). Table 6.6-2 assigns each hazard a severity

¹ *Murrieta Emergency Operations Plan, Part 1: Basic Plan*, and *City of Murrieta Emergency Operations Plan, Part 2: Supporting Documents*, City of Murrieta, June 2008.

² Ibid



rating, indicating the amount of damage that would be done to the County and the City and its population should the hazard occur. Table 6.6-2 also assigns a probability rating, indicating the likelihood that the hazard may occur within the County and City. Both ratings are on a scale of 0-4, with 4 being the most severe or the most likely to occur. Within the County, earthquakes are assigned a severity rating of 4 and a probability rating of 3. Within the City, earthquakes are assigned a severity rating of 4 and a probability rating of 3.

5.8.2 ENVIRONMENTAL SETTING

For purposes of this section, and to remain consistent with the *Seismic and Geologic Hazards Review General Plan 2035, City of Murrieta, California* technical report prepared by Leighton and Associates (2009), the City was divided into three corridor areas for discussion purposes. These corridors will be referred to as Geology Study Areas 1 through 3 and may be generally described as follows:

- ***Geology Study Area 1 – Southwest Murrieta/Jefferson Business Corridor:*** The major retail and light industrial agglomeration within Murrieta and located generally west of the Golden Triangle along the west side of Interstate 15 (I-15), south of Kalmia Street and north of the City’s southern boundary.
- ***Geology Study Area 2 – Golden Triangle:*** Located north of the intersection of I-15 and Interstate 215 (I-215) and south of Los Alamos Road.
- ***Geology Study Area 3 – Northeast I-215 and Clinton Keith Road:*** The northeastern quadrant of the City located along the east side of I-215 and north of Clinton Keith Road where relatively most vacant land currently exists.

REGIONAL SETTING

The City of Murrieta is located within the northern portion of the Peninsular Range geomorphic province which is characterized by steep, elongated valleys and ranges that generally trend northwestward from the tip of Baja California to the Los Angeles Basin. The City is regionally located at the base of the Santa Ana Mountains and the Santa Rosa Plateau, the Santa Margarita and Agua Tibia ranges are located approximately 12 to 14 miles to the south, and the San Jacinto ranges lie approximately 35 miles to the east. More specifically, Murrieta is situated within two structural blocks or subdivision of the Peninsular Range province. The western foothill boundary of the City is within the Santa Ana Mountains block and the east portion is within the Perris block. The provinces are separated by the active Elsinore fault zone, which forms a complex pull-apart basin (locally referred to as the Temecula Valley) that is filled with sedimentary deposits. The relatively stable Santa Ana Mountains and Perris Block are underlain by pre-Cretaceous aged metasedimentary rocks and Cretaceous aged plutonic rocks of the southern California batholith. Tertiary-aged sediments, volcanics, and Quaternary-aged sediments flank the Santa Ana mountain range to the west, elevated portions of the valley floor,



and within the western flanks and localized valleys of the Perris Block. The Quaternary sediments include the “Unnamed” Sandstone, Pauba Fanglomerate, Pauba Sandstone, and younger alluvial sediments.

AREA GEOLOGY

The City is underlain by several surficial deposits and/or bedrock units based on published geologic maps; refer to *Exhibit 5.8-1, Regional Geology Map*. The surficial deposits and bedrock units that are most likely to be encountered during future developments are described below:

- ***Artificial Fill (not a mapped unit):*** Artificial fills are generally referred to as undocumented fills or engineered (documented) fills. Undocumented fills are typically those fills that were placed without the review and testing of a geotechnical consultant. Engineered fills are those fills that were observed and tested by a geotechnical consultant. Most artificial fills within the City are expected to be engineered and placed during construction of existing public roads and private developments. The engineering characteristics and vertical or horizontal extent of these fills are site-specific.
- ***Colluvial Deposits (not a mapped unit):*** Colluvium is the name for sediments that have been built up or deposited at the bottom of a low-grade slope or against a barrier on that slope, transported by gravity. As such, these deposits generally consist of silty sand and sandy gravel with abundant angular and sub-angular fragments of the underlying bedrock units.
- ***Young Axial-Channel Deposits (map symbol Qya):*** These alluvial deposits (late Holocene) are generally found in active stream beds, channels or flood plains and consist of unconsolidated to locally poorly consolidated sand and gravel with small amounts of silt.
- ***Young Alluvial-Valley Deposits (map symbol Qyv):*** These alluvial flood plain deposits (Pleistocene, younger than 500,000 years) are generally found along the main Murrieta Creek channel and expected to exceed 100 feet in depth. These deposits are found throughout the main channel areas of Area 1 (Southwest Murrieta/Jefferson Business Corridor: the major retail and light industrial agglomeration within Murrieta and located generally west of the Golden Triangle along the west side of Interstate I-15, south of Kalmia Street and north of the City’s southern boundary).
- ***Pauba-sandstone (map symbol Qps):*** The Pauba-sandstone formation (Pleistocene) is moderately well-indurated, extensively crossbedded, channeled and filled sandstone and siltstone that contains local intervening cobble-and-boulder conglomerate beds. The formation is generally found in the southern half of the City including portions of Area 1 and most of Area 2 (Golden Triangle: north of the intersection of I-15 and I-215 and south of Los Alamos Road).



- ***Pauba-fanglomerate (map symbol Qpf):*** The Pauba-fanglomerate member (Pleistocene) is well indurated, poorly sorted fanglomerate and mudstone and generally found along the east flank of the Santa Ana Mountains (west of Murrieta).
- ***Basalt of the Hogbacks (not mapped):*** The locally named Hogbacks are an elevated hilltop located in the eastern portion of the City. Capping this unique feature is a remnant channel filled with basalt (Tertiary-age).
- ***Monzogranite to Granodiorite Bedrock (map symbol Kpvg):*** The Cretaceous-age formation locally known as the Paloma Valley Ring Complex constitutes portion of the hills along the northern part of the City and underlies the older alluvium in Area 3 (Northeast I-215 and Clinton Keith Road: the northeastern quadrant of the City located along the east side of Interstate 215 and north of Clinton Keith Road where relatively most vacant land currently exists).
- ***Gabbro Bedrock (map symbol Kgb):*** The Cretaceous-age formation also constitutes portions of the hills along the northern part of the City and underlies the older alluvium in Area 3.
- ***Metasedimentary Rock (map symbol Mzu):*** The Mesozoic-aged metamorphic grade sedimentary rock unit exists in the northeastern quadrant of the City and also constitutes most of the Santa Ana plateau to the west of the City. The bedrock unit consists of laminated to thinly bedded metasilstone, claystone, and shale.

GEOLOGIC HAZARDS

The potential extent and severity of any non-earthquake related geologic hazard varies throughout the General Plan Planning Study Area depending upon the underlying geology, topography, groundwater conditions, and soil type. The most common geologic hazards that may be encountered within the City are expansive soils, collapsed soils, loading settlement, subsidence, and hazardous minerals/radon.

Expansive Soils

Expansive soils are surface deposits rich in clays that expand when wet and shrink when dried. The change in volume can exert detrimental stresses on buildings and cause structural damage. Expansive soils can be widely dispersed and can be found in hillside areas as well as low-lying alluvial basins. There have been reported cases of expansive clay layers within the Pauba formation and Alluvial-Valley deposits.



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Collapsed Soils

The collapsed soils process, or hydro-consolidation, typically occurs in recently deposited soils (Holocene age – less than 10,000 years old) that were deposited in an arid or semi-arid environment. These soils typically contain a high percentage of voids and possess low relative density. The soil particles may be partially supported by clay or silt, or chemically cemented with carbonates. When inundated by water, the soils collapse and substantial settlement occurs.

Damage to structures and ground cracking due to hydro-consolidation (collapse) of recent alluvial deposits has occurred in the California Oaks area of Murrieta. Documented collapsible soils in the California Oaks area were documented to be the most severe and resulted in significant property damage. It was determined that the alluvium was left in place during rough grading, and later collapsed when ground water levels rose due to rise in groundwater or irrigation.

Loading Settlement

Loading settlement can be immediate or occur gradually over a long period of time. Immediate settlement is normally associated with loose granular soils when subjected to loads. Long-term or consolidations settlement normally takes place in soft saturated silts and clays. These soils are generally found in young alluvium or loosely deposited materials.

Subsidence

Subsidence is the ground settlement that results over time from the extraction of oil or groundwater. This process usually extends over a large area and occurs on a gradual basis so the settlement effects on a single site, relative to its immediate neighbors, may be negligible as the neighboring properties are also subsiding. However, ground fissuring due to subsidence can cause structural damage and should be evaluated by the site specific geotechnical report. Although there are no reports of significant subsidence due to groundwater withdrawal in the City, alluvial valley areas are considered susceptible; refer to *Exhibit 5.8-2, Subsidence Susceptibility Map*.

Hazardous Materials/Radon

Naturally occurring geologic formations throughout California may contain minerals that are considered hazardous. Hazardous minerals include asbestos, mercury and rocks that contain small amounts of uranium and thorium that decay and release radioactive radon gas. Radon gas is a naturally occurring radioactive gas that is tasteless, odorless, and invisible. Radon gas becomes hazardous when confined in buildings and the long term exposure levels in the air exceed the United States Environmental Protection Agency's (U.S. EPA) concentration of 4 picocuries per liter (4pCi/L). Per the California Department of Public Health Services website, rocks containing the minerals that release radon gas exist in the Murrieta area.



Seismicity and Faulting

The City of Murrieta, like the rest of southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates. The most significant known active fault zones that are capable of seismic ground shaking and can impact the City are the Elsinore Fault Zone, San Jacinto Fault Zone, Newport-Inglewood Fault Zone, and the San Andreas Fault Zone.

Elsinore Fault Zone: The Elsinore Fault Zone, which includes the local Elsinore-Temecula fault, passes through the City to the west of Interstate I-15; refer to *Exhibit 5.8-3, Alquist-Priolo Earthquake Fault Zone Map* and *Exhibit 5.8-4, Riverside County Fault Hazard Map*. The Elsinore-Temecula Fault Zone is capable of generating a Maximum Earthquake Magnitude (Mw) of 6.8 per the Richter scale.

San Jacinto Fault Zone: The San Jacinto Fault Zone is located approximately 21 miles northeast of the City and is capable of generating earthquakes in excess of 7.2 Mw.

Newport-Inglewood Fault Zone (offshore): The Newport-Inglewood Fault Zone is located approximately 28 miles southwest of the City and is capable of generating earthquakes in excess of 6.9 Mw.

San Andreas Fault Zone (southern section): The San Andreas Fault Zone is located approximately 38 miles northeast of the City and is considered the dominant active fault in California. This fault zone is capable of generating earthquakes in excess of 7.4 Mw.

The State Geologist designates seismic hazard zones and the State issues earthquake fault zone maps to assist cities and counties in avoiding the hazard of surface fault rupture. The State identified two Alquist-Priolo Earthquake Fault Zones within Murrieta. The Temecula Segment of the Elsinore Fault Zone traverses the City and the Murrieta Creek Fault is located at the extreme southwest corner of the City; as shown in *Exhibit 5.8.3, Alquist-Priolo Earthquake Fault Zone Map*. The earthquake fault zones extend approximately 500 feet in width on either side of a major active fault trace and approximately 200 to 300 feet in width on either side of a well defined minor active fault, as designated by the State. Development of a building designated for human occupancy is generally restricted within 50 feet of an identified fault.

In addition to the State Alquist-Priolo Hazards Act mapping, the County of Riverside has zoned fault systems and required similar special studies prior to land development. These are referred to as County Earthquake Fault Zones as shown in *Exhibit 5.8-4, Riverside County Fault Hazard Map*.



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Fault Rupture

Faults throughout southern California have formed over millions of years. Some of these faults are generally considered inactive under the present geologic conditions. As mentioned above, several State and County fault systems are mapped within the City boundaries and any proposed tracts of four or more dwelling units or critical structures including hospitals, emergency structures, or schools must investigate the potential for and setback from ground rupture hazards. Typically, this is accomplished by excavation of a trench across the site, determining the location of faulting and establishing building setbacks.

Ground Shaking

The intensity of earthquake ground shaking varies from one area to another depending primarily upon the distance to the fault, magnitude of the earthquake, and the local geology. The effect of seismic shaking on future structures and land development projects within the City may be mitigated by adhering to the *CBSC* or applicable codes and standards at the time. Site-specific peak and spectral accelerations are to be developed in accordance with the *CBSC*, and the guidelines included in American Society of Civil Engineers Standard 7-05. Typical seismic design values per the *CBSC* for study areas 1 through 3 are provided below. The *CBSC* regulates the design and construction of foundations, building frames, retaining walls, excavations, 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, structural system, height, configuration, and seismic zoning.

Secondary Seismic Hazards

Ground shaking can induce secondary seismic hazards such as liquefaction, lateral spreading, subsidence, ground fissuring, and landslides.

Dynamic Settlement/Liquefaction

Liquefaction of saturated cohesionless soils can be caused by strong ground motion resulting from earthquakes. Soil liquefaction is a process in which saturated, cohesionless soils lose their strength due to the build-up of excess pore water pressure during cyclic loading such as that induced by earthquakes. The primary factors affecting the liquefaction potential of 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 non-plastic silts that are saturated. Silty sands, under specific site conditions, may also be susceptible to liquefaction. A majority of the alluvial deposits along the Murrieta Creek lie within a liquefaction hazard zone per County of Riverside; refer to *Exhibit 5.8-5, Liquefaction Susceptibility Map*. Most of these alluvial soils are also considered susceptible to liquefaction per State Seismic Hazard Zones; refer to *Exhibit 5.8-6, State Seismic Hazard Zones*.



Lateral Spreading

The process of liquefaction may also produce lateral spreading of soils adjacent to a body of water or water course (Murrieta Creek and Warm Springs Creek). Lateral spreading is therefore considered a liquefaction-induced ground failure whereby block(s) of surficial intact natural or artificial fill soils displace downslope or towards a free face along a shear zone that has formed within the liquefied sediment. The displacement of the ground surface associated with the lateral spreading may be on the order of several inches to several feet at the top of the slope and may affect areas well beyond the top of slope. Developments located further from the creeks or drainage courses are anticipated to be at less risk from lateral spreading than those adjacent to the creek embankment.

Differential Subsidence and Ground Fissuring

Ground fissuring typically develops along previous established planes of weakness such as possibly potentially active and active fault traces as well as along steep buried contacts between bedrock to recent alluvial soils. The active Elsinore-Temecula and the Murrieta Creek Fault may develop fissuring along the fault trace during a significant seismic event or groundwater elevation change. As such, there is a low to high potential for ground fissuring and associated differential subsidence along the active fault zones. If commercial water wells are installed within or near the subsidence zone, the potential for ground fissuring and differential settlement could be substantially increased.

Landslides

The potential for earthquake-related landsliding within the City limits is based on known conditions and published geologic maps. Several old landslides have been mapped in areas along the Santa Ana Mountains eastern slopes and the hills along the northern side of the City. The State Seismic Hazard Zones provides locations of previous known landsliding or where local conditions indicate a potential for ground displacements; as shown in *Exhibit 5.8-6, State Seismic Hazard Zones*.

Rock Fall Hazards

The potential for rock fall due to natural weathering and instability or rock falls due to a seismic event are possible in areas of the City. The hazard areas are limited to those properties at the base of hill sides where rocks and boulders exist.

Seiches and Tsunamis

Due to the great distance to large bodies of water, the possibility of seiches and tsunamis impacting the City is considered remote. The nearest large body of water is Lake Elsinore, located approximately 6¼ miles northwest.



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5.8.3 SIGNIFICANCE THRESHOLD CRITERIA

The issues presented in the Initial Study Environmental Checklist (Appendix G of the *CEQA Guidelines*) have been utilized as thresholds of significance in this Section. Accordingly, geology and seismic hazard impacts resulting from the implementation of the proposed General Plan 2035 may be considered significant if they would result in the following:

- 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 Zone 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.
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in landslides, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risk to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

Based on these significance thresholds and criteria, the proposed General Plan 2035's effects have been categorized as either "no impact," a "less than significant impact," or a "potentially significant impact." Mitigation measures are recommended for potentially significant impacts. If a potentially significant impact cannot be reduced to a less than significant level through the application of mitigation, it is categorized as a significant unavoidable impact.



5.8.4 PROJECT IMPACTS AND MITIGATION MEASURES

FAULT RUPTURE AND SEISMIC GROUNDSHAKING

- **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN 2035 COULD EXPOSE PEOPLE AND STRUCTURES TO POTENTIALLY SUBSTANTIAL ADVERSE EFFECTS INVOLVING FAULT RUPTURE OR STRONG SEISMIC GROUNDSHAKING.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: The City of Murrieta, like the rest of southern California, is located within a seismically active region as a result of being located near the active margin between the North American and Pacific tectonic plates. The most significant known active fault zones that are capable of seismic ground shaking and can impact the City are the Elsinore Fault Zone, San Jacinto Fault Zone, Newport-Inglewood Fault Zone, and the San Andreas Fault Zone. The Elsinore fault zone runs through the City on the west side of I-15. Furthermore, the San Jacinto, Newport-Inglewood, and San Andreas Fault Zones, all capable of generating ground shaking in Murrieta, are all located within 40 miles of the City. The City is situated on undocumented fill, alluvial deposits, pauba formation, granitic rock, and would likely experience groundshaking due to a seismic event.

The intensity of groundshaking would depend upon the magnitude of the earthquake, distance to the epicenter and the geology of the area between the epicenter and the City. Development anticipated under the proposed General Plan 2035 potentially would result in the addition of 10,734 dwelling units and 36,210,757 square feet throughout the City, thereby exposing more residents and employees to the effects of ground shaking from locally and regionally generated earthquakes.

Strong seismic groundshaking could result in substantial damage to some new buildings within the City. The effects of groundshaking would be sufficiently mitigated for buildings designed and constructed in conformance with current building codes and engineering standards. However, there is the possibility of partial to total collapse of buildings built prior to 1933 and some tilt-up concrete block buildings built prior to 1972. Structural vulnerabilities in older buildings that are less earthquake resistant are most likely to contribute to the largest source of injury and economic loss as a result of an earthquake. However, most of the existing homes in the City were constructed after the adoption of modern building codes, which have been established to reduce seismic impacts on structures.

Implementation of the proposed General Plan 2035 could expose people or structures to potential substantial adverse effects as a result of strong seismic groundshaking. Impacts associated with seismically-induced groundshaking would be considered significant, unless mitigated.



Mitigation has been recommended in order to reduce impacts associated with seismically induced groundshaking to less than significant levels. The mitigation involves compliance with the recommendations detailed in site-specific Geotechnical Studies conducted as part of future development. Also, numerous controls would be imposed on future development through the permitting process that would further lessen impacts associated with seismically-induced groundshaking. The design, construction, and engineering of buildings within the City would be subject to compliance with the City's *Building Code* and *CBSC*. Additionally, the proposed General Plan 2035 Safety Element includes goals and policies to protect the community from risks associated with seismic hazards. These measures acknowledge safety concerns pertaining to seismic groundshaking. All future development would be subject to compliance with applicable building codes (i.e., City Building Code, California Building Standards Code), proposed General Plan 2035 Safety Element goals and policies, the Local Hazards Mitigation Plan, and recommended mitigation, which would lessen potential impacts associated with fault rupture and strong seismic groundshaking to less than significant levels.

Goals and Policies in the Proposed General Plan 2035:

SAFETY ELEMENT

Goal SAF-2 Damage from geologic and seismic hazards is minimized by identifying and addressing these hazards during the planning and engineering of built improvements.

Policies

SAF-2.1 Prior to site development, projects located in areas where liquefaction, subsidence, landslide and fissuring are considered hazards shall be required to prepare geologic reports addressing site conditions, potential risk, and mitigation, to the satisfaction of the City Engineer.

SAF-2.2 Require that all new development comply with the Alquist-Priolo Earthquake Fault Zoning Act.

SAF-2.3 Seek to maintain emergency access in the event of an earthquake by engineering roadways to reduce damage to them.

Goal SAF-12 Murrieta is prepared to coordinate effective response and recovery efforts for major emergencies.

Policies

SAF-12.1 Maintain an effective, coordinated and up-to-date Emergency Operations Plan in partnership with the Riverside County and other agencies.



- SAF-12.2 Support a safe, secure, and technologically advanced Emergency Operations Center (EOC) to coordinate the City's response to disasters and maintain training of City personnel in operation of the EOC.
- SAF-12.3 Review and test the City's Emergency Operations Plan periodically to note any deficiencies or practices requiring modification.
- SAF-12.4 Provide training to maintain City staff proficiency in implementation of the Emergency Operations Plan, for all staffing levels.
- SAF-12.5 Provide public outreach, presentations, and information that prepares residents and businesses to safeguard life and property during and immediately after emergencies.
- SAF-12.6 Participate in regularly scheduled disaster exercises to better prepare Police, Fire and other City employees with disaster responsibilities.
- SAF- 12.7 Continue to participate in maintaining the Riverside County Multi-Jurisdictional Local Hazard Mitigation Plan, and incorporate it into City planning efforts as appropriate.

Mitigation Measures:

- GEO-1 Prior to issuance of a Grading Permit for each future development project, a registered geologist or soils engineer shall prepare an area-specific Geologic Study, which shall be submitted to the Public Works or Building and Safety Department for approval. The Geologic Study shall specify the measures necessary to mitigate impacts related to fault rupture, groundshaking, landslides, liquefaction or dynamic settling, expansive or collapsible soils, lateral spreading, and other geologic and seismic hazards, if any. All recommendations in the Geologic Study shall be implemented during area preparation, grading, and construction.
- GEO-2 Prior to issuance of any Grading Permit, project applicants of future development projects shall comply with each of the recommendations detailed in the Geotechnical Study, and other such measure(s) as the City deems necessary to adequately mitigate potential seismic and geotechnical hazards.

Level of Significance After Mitigation: Less than Significant Impact.



GROUND FAILURE

- **IMPLEMENTATION OF THE PROPOSED GENERAL PLAN 2035 COULD EXPOSE PEOPLE AND STRUCTURES TO POTENTIAL SUBSTANTIAL ADVERSE EFFECTS FROM SEISMIC-RELATED OR OTHER TYPES OF GROUND FAILURES.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: Implementation of the proposed General Plan 2035 would result in potential significant impacts involving the exposure of people or structures to potential substantial adverse effects, particularly in the Geology Study Areas involving earthquake-induced landslides or differential subsidence and ground fissuring.

Earthquake-Induced Landslides. Several landslide areas have been mapped in areas along the Santa Ana Mountains and the hills along the northern side of the City, as shown in *Exhibit 5.8-6, State Seismic Hazard Zones*. Thus, there is the potential for landslides in the Clinton-Keith/Mitchell and the South Murrieta Business Corridor Focus Areas.

Differential Subsidence and Ground Fissuring. Fissuring typically develops along previous established planes of weakness such as active and potentially active faults. The active Elsinore-Temecula and the Murrieta Creek fault may develop fissuring along the fault trace during a significant seismic event or groundwater elevation change. As such, there is a low to high potential for ground fissuring and associated differential subsidence along the active fault zones.

In addition, portions of the City of Murrieta are subject to liquefaction, “dry” settlement, and lateral spreading during a seismic event because of the presence of alluvial-channel deposits, particularly located in Geology Study Areas 1 and 2, which correspond to the South Murrieta Business Corridor and the Golden Triangle North (Central Murrieta) Focus Areas.

Site-specific reports would be required for future development projects (Mitigation Measure GEO-1), including an evaluation of liquefaction hazards or dynamic densification of dry or moist soil above the water table. The site-specific evaluation for future development projects would need to include an evaluation for settlement associated with dynamic densification of dry soils. To reduce the effects and magnitude of seismically-induced dynamic settlements, remedial grading measures or ground improvement techniques are normally implemented. In addition, the site-specific reports should determine whether the potential for landsliding or slope instability exists, and whether buttressing or other slope stabilization methods are required. The reports should also identify the potential presence of such soils based on laboratory testing and provide mitigation measures to reduce their impact on the proposed improvements. Such measures typically include compacting and removing of the collapsible soils.



Impacts related to ground failure are considered significant unless mitigated. Mitigation Measure GEO-1 requires site-specific geologic investigation of liquefaction potential, as well as any other geologic and seismic hazards and mitigation measures. Mitigation Measures GEO-2 requires the implementation of recommended measures identified in a Geotechnical Study to reduce impacts. Further, the Seismic Hazards Mapping Act specifies that the lead agency may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils. If a geologic report concludes liquefaction impacts cannot be reduced to less than significant with mitigation as necessary, development would not be permitted. Therefore, following compliance with the proposed General Plan 2035 Safety Element goals and policies and with the recommended mitigation measures, impacts would be less than significant in this regard.

Goals and Policies in the Proposed General Plan 2035: Refer to the goals and policies referenced above in this Section 5.8.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

SOIL EROSION/LOSS OF TOPSOIL

■ IMPLEMENTATION OF THE PROPOSED GENERAL PLAN 2035 COULD RESULT IN IMPACTS RELATED TO SOIL EROSION OR LOSS OF TOPSOIL.

Level of Significance Before Mitigation: Less Than Significant Impact.

Impact Analysis: Construction activities associated with future development projects within the City have the potential to result in soil erosion during excavation, grading and soil stockpiling, subsequent siltation, and conveyance of other pollutants into municipal storm drains. Construction associated with future development would be required to comply with the requirements of the Municipal National Pollutant Discharge Elimination System (NPDES) Construction Permit and would implement City grading permit regulations that include compliance with erosion control measures, including grading and dust control measures.

Specifically, construction associated with future development projects must comply with *Title 15*, Chapter 15.52, of the City's *Municipal Code*, which requires necessary permits, plans, plan checks, and inspections to reduce the effects of sedimentation and erosion. In addition, construction associated with future development projects would be required to have erosion control plans approved by the City of Murrieta Departments of Public Works and Building and



Safety, as well as Storm Water Pollution Prevention Plans (SWPPP). As part of these requirements, Best Management Practices (BMPs) would be implemented during construction activities to reduce soil erosion to the maximum extent possible. Furthermore, all construction activities would be required to comply with SCAQMD Rule 403 regarding the control of fugitive dust. Therefore, compliance with the proposed General Plan 2035 Safety Element goals and policies, and compliance with the City's applicable building regulations regarding erosion control and SCAQMD Rule 403 would ensure that impacts related to soil erosion during construction phases of future development projects would be less than significant.

Goals and Policies in the Proposed General Plan 2035: Refer to the goals and policies referenced above in this Section 5.8.

Mitigation Measures: No mitigation measures beyond the goals and policies identified in the proposed General Plan 2035 are required.

Level of Significance After Mitigation: Not Applicable.

SOIL

- **FUTURE DEVELOPMENT RESULTING FROM IMPLEMENTATION OF THE PROPOSED GENERAL PLAN 2035 COULD RESULT IN IMPACTS RELATED TO EXPANSIVE SOILS, SOIL STRENGTH, OR THE POTENTIAL TO SUPPORT SEPTIC TANKS OR ALTERNATIVE WASTE WATER DISPOSAL SYSTEMS.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: The City is underlain primarily by several surficial deposits and/or bedrock units. These deposits include alluvial-valley and alluvial-channel deposits which are made of gravel, sand, silt, and clay, and are subject to liquefaction. In some areas, these soil types exceed 100 feet in depth. In some areas, groundwater is estimated to be at a depth of 10-30 feet below ground surface. Soils with a percentage of clay have the potential to expand when water is added and shrink when water is lost, resulting in what is called expansive soils. Expansive soils can result in damage to overlying structures and infrastructure.

Site-specific reports would be required for future development projects (Mitigation Measure GEO-1) and these reports, typically identify the extent of the expansive soils and provide mitigation measures to reduce their impact on the proposed improvements. Such measures may include structural mitigation or ground improvement. In addition, the *California Building Standards Code* contains minimum requirements for construction on expansive soils.



In addition, in areas that are not currently supported by water or wastewater infrastructure (refer to *Section 5.15, Water Supply*, and *Section 5.16, Wastewater*, future development would be required to install septic systems or alternative waste water disposal systems. Prior to the installation of such systems, project applicants would be required to comply with applicable City or Riverside County requirements. However, future development projects associated with the implementation of the proposed General Plan 2035 are not anticipated to create impacts to soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste. Impacts are considered less than significant in this regard.

Future development projects associated with implementation of the proposed General Plan 2035 would be required to comply with all applicable building codes (i.e., *City Building Code*, and *California Building Standards Code*) and Mitigation Measures GEO-1 and GEO-2. Therefore, compliance with the proposed General Plan 2035 Safety Element goals and policies, and with the recommended mitigation measures would reduce impacts regarding expansive soils to a less than significant level.

Goals and Policies, in the Proposed General Plan 2035: Refer to the goals and policies referenced above in this Section 5.8.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

5.8.5 CUMULATIVE IMPACTS AND MITIGATION MEASURES

■ **DEVELOPMENT ASSOCIATED WITH IMPLEMENTATION OF THE PROPOSED GENERAL PLAN 2035 AND CUMULATIVE DEVELOPMENT COULD RESULT IN CUMULATIVELY CONSIDERABLE IMPACTS RELATED TO SEISMIC, GEOLOGIC, AND SOIL CONDITIONS.**

Level of Significance Before Mitigation: Potentially Significant Impact.

Impact Analysis: Although conditions conducive to potential seismic and geologic hazards occur regionally, the increased exposure of people and structures to these hazards resulting from buildout of the proposed General Plan 2035 would be specific to the City of Murrieta. However, increased growth within the subregion, as a result of the proposed General Plan 2035 and other projects, would contribute to the cumulative exposure of people and structures to geologic and seismic hazards. As concluded above, impacts related to seismic, geologic, and soil conditions



associated with implementation of the proposed General Plan 2035 would be less than significant with adherence to the *CBSC*, *Municipal Code*, and NPDES requirements. Unsafe seismic, geologic, and soil conditions exist throughout southern California and new development in such areas could result in potentially significant impacts. These potential impacts would be evaluated on a project-by-project basis in accordance with CEQA. If a specific site were determined to create a significant impact that could not be feasibly mitigated, the site would not be appropriate for development. Individual development projects under the proposed General Plan 2035 would undergo site-specific evaluation to determine the threat and the cumulative threat of regional seismic and geologic hazards. This process, along with compliance to the proposed General Plan 2035 Safety Element goals and policies, Federal and State laws, local building codes, and public safety standards would result in less than significant cumulative impacts related to potential seismic, geologic, and soil hazards. Therefore, implementation of the proposed General Plan 2035 would not result in cumulatively considerable impacts involving seismic and geologic hazards.

Goals and Policies, in the Proposed General Plan 2035: Refer to the goals and policies referenced above in this Section 5.8.

Mitigation Measures: Refer to Mitigation Measures GEO-1 and GEO-2. No additional mitigation measures are required.

Level of Significance After Mitigation: Less Than Significant Impact.

5.8.6 SIGNIFICANT UNAVOIDABLE IMPACTS

Impacts related to geologic, soil, and seismicity associated with implementation of the proposed General Plan 2035 would be less than significant by adherence to and/or compliance with policies and implementation measures in the proposed General Plan 2035. No significant unavoidable geologic, soil, and seismic impacts would occur as a result of buildout of the proposed General Plan 2035.

5.8.7 SOURCES CITED

Seismic and Geologic Hazards Review General Plan 2035, City of Murrieta, California technical report, Leighton and Associates, December 2009.

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City of Murrieta General Plan, prepared by EIP Associates, June 1994.

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Murrieta Emergency Operations Plan, Part 1: Basic Plan, and City of Murrieta Emergency Operations Plan, Part 2: Supporting Documents, City of Murrieta, June 2008.

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