4.7 Geology and Soils

4.7.1 Setting

All three counties in the AMBAG region are part of the Coast Ranges geomorphic province, a region dominated by active tectonics at the margin of the Pacific and North American tectonic plates (Monterey County 2008). Existing geologic, soils and flooding conditions for each county are briefly summarized below. Figure 25, Figure 26 and Figure 27 show known active faults in each county.

a. Monterey County

At the southwestern portion of AMBAG’s planning area, Monterey County has approximately 100 miles of coastline, two coastal ranges (the Santa Lucia and Gabilan Mountain Ranges) and two valleys (the Salinas and Carmel Valleys).

Geologic Formations

The interaction between Pacific and North American tectonic plates has created the primary geologic formations in Monterey County, as uplift along faults is largely responsible for the formation of the Coast Ranges, including the Santa Lucia and Gabilan Ranges. These granitic and metamorphic mountain ranges trend in a northwest-southeast direction, with the Santa Lucia Range along the coast and the Gabilan Range along Monterey County’s eastern border (RWMG 2013). Located between the Santa Lucia and Gabilan mountain ranges is the Salinas Valley, a broad basin filled with several thousand feet of sediment. This valley is 130 miles long and generally 10 to 20 miles wide. The northern part of Monterey County, between the Salinas River mouth and the Pajaro Valley, has a more undulating topography and wide sandy beaches at the coastline.

Earthquake Ground-shaking and Fault Rupture

According to the Monterey County Multi-Jurisdictional Hazard Mitigation Plan, several active faults run through the County (Monterey County 2014). These faults include but are not limited to the San Andreas, Reliz, Chupines, Tularcitos, Berwick, Navy, Sylvan, Hatton and Vergeles Faults (see Figure 25). Historically, most of the earthquakes that have occurred in Monterey County originated from movement along the San Andreas Fault system, which runs through the southeastern portion of the county for approximately 30 miles. This fault system is the most active in California and, in its entirety, runs 800 miles along the California coastline. Fault rupture can occur during severe earthquakes and produce ground surface displacements (vertical or horizontal offsets) ranging in severity. Where these faults cross structures (roads, bridges, buildings), substantial damage can occur which can cause injury to occupants or users. The highest potential for fault rupture is directly on the active faults.

Monterey County also is susceptible to high levels of ground-shaking due to the numerous active faults which pass through or border the county. The portions of Monterey County with the highest susceptibility to ground-shaking are the lower Salinas Valley (northward from the City of Gonzales), the peninsular area from Carmel to the Santa Cruz County line and in the southeast around Parkfield.
Figure 25 Monterey County Fault Zones

Source: Monterey County General Plan Draft EIR, Exhibit 4.4.1, 2008.
Figure 26 San Benito County Fault Zones

Source: San Benito County, 2017a
Figure 27 Santa Cruz County Fault Zones

Fault Zone Hazard Areas
County of Santa Cruz

Zones of fracture designated in the Seismic Safety Element of the General Plan/Local Coastal Plan and California State designated Seismic Review Zones. Fault zones designated for review by the County include the Burton, Sangari, Zayante, and Corralitos complexes. State-designated seismic review zones include the San Andreas, and portions of the Zayante and Burton complexes.

Features within 0.5 Mile of Fault Zones
- 13,193 Parcels
- 11,354 Structures
- 12 Schools
- 7 Fire Stations

Value of improvements based on Assessment Roll 10/13/2009
$1,429,745,892

Legend
- Fire Stations
- Public and Private Schools
- Fault Zones
- 0.5 Mile Buffer of Fault Zones

Prepared by the Santa Cruz County GIS November 2009, Project # 004-CB

Source: Santa Cruz County GISWeb, 2012
Liquefaction and Lateral Spreading

Liquefaction, or the loss of soil bearing strength during a strong earthquake, is a potential occurrence in areas with younger soils as well as in areas where the groundwater table is less than 50 feet deep. Specifically in areas of loose sand and silt that is saturated with water, soils can behave like liquid during earthquakes. Liquefaction can cause serious damage to foundations and bases of structures (USGS n.d.). Liquefaction in a subsurface layer can cause lateral spreading of the ground surface, which usually occurs along weak shear zones that have formed within the liquefiable soil layer. Lateral spreading has generally been observed to take place in the direction of a free face (e.g., a retaining wall or slope). In Monterey County, this condition occurs mainly along the Salinas River and floodplain, the Moss Landing and Elkhorn Slough areas, the Carmel River and floodplain, the San Antonio and Lockwood Valleys and the Peachtree and Cholame Valleys (Monterey County 2008). The severity of ground deformation due to liquefaction is dependent on the density and depth of the liquefied material. Shallower materials experience the most severe effects.

Slope Stability

Landslides and surficial slope failures are most likely to occur in areas of greater than 25 percent slope (hillside areas) and along steep bluffs. Landslides also occur due to specific events, such as loss of vegetation after fires or earthquakes adding loads to barely stable slopes. Monterey County is vulnerable to slope instability in the Santa Lucia Mountain Range and fault zones, especially after prolonged rainfall. In general, mountainous areas and steeply sloped streambanks are most susceptible to landslides or mudflows when soils are wet, particularly adjacent to areas of unstabilized cut or fill. High susceptibility to earthquake-induced landslides does not generally occur in the urbanized areas of Monterey County, including cities in the Salinas Valley or along the Monterey Peninsula (Monterey County 2008).

Expansive Soils

Soils with relatively high clay content are expansive because the clay absorbs water and swells (expands). Because the bedrock and soils contain relatively high amounts of clay, the potential for soil expansion occurs throughout the County. However, the Monterey County Multi-Jurisdictional Hazard Mitigation Plan does not identify substantial risks from expansive soils and states that no historic events related to this hazard have occurred in the County (Monterey County 2014).

Subsidence

Subsidence is a process that occurs in response to the voids created by extracting solids or liquids from beneath the Earth’s surface. Subsidence is controlled by many factors including mining methods, depth of extraction, thickness of deposit and topography. Impacts from subsidence can be serious if damage occurs to structures or effects ground-water conditions (Lee and Abel 1983). Monterey County includes areas with oil mining and groundwater extraction that can be at risk from subsidence. However, there is little evidence of widespread land subsidence from drainage or organic soils, underground mining, or hydrocompaction in Monterey County. The Carmel Valley includes soils that are comprised of Holocene deposits, which could be susceptible to subsidence as a result of groundwater extraction in the underlying aquifer (Monterey County 2015).
b. San Benito County

Located in the eastern portion of AMBAG’s planning area, San Benito County topography is dominated by the Diablo and Gabilan Mountain ranges and the valleys between these ranges.

Geologic Formations

In the north-central portion of San Benito County lie the relatively flat San Juan, Hollister and Santa Ana valleys, which are composed of alluvium. The Diablo and Gabilan Ranges are located to the east and west of these valleys, respectively. According to the San Benito County General Plan EIR (San Benito County, 2015b), the Diablo and Gabilan Ranges consist of highly deformed and metamorphosed sedimentary and igneous rocks. These rock formations have been intensely deformed during the collision of the North American Plate and the Pacific Plate, and have undergone low grades of metamorphism. The low grade metamorphism has resulted in the alteration of ultramafic rocks to asbestos-containing formations.

Earthquake Ground-shaking and Fault Rupture

Several well-known geologic features traverse San Benito County. The most substantial is the San Andreas Fault, which runs the length of the county stretching 60 miles from the Santa Cruz County line in the north to the Monterey County line in the south (San Benito County, 2015b). Other notable faults in San Benito County include the Calaveras (principal active fault), Sargent, Paicines, Bear Valley, Zayante-Vergeles and Quien-Sabe Faults. In San Benito County, the highest ground-shaking potential occurs in the north-central valley region, including the Cities of Hollister and San Juan Bautista (see Figure 26).

Liquefaction and Lateral Spreading

Although San Benito County is not subject to any recognized hazard areas for liquefaction, the risk of liquefaction and lateral spreading is considered highest near Quaternary alluvial deposits where soil saturation is close to the land surface. Specifically in areas of loose sand and silt that is saturated with water, soils can behave like liquid during earthquakes. Liquefaction can cause serious damage to foundations and bases of structures (USGS n.d.). The potential for liquefaction and thus lateral spreading is recognized throughout the Santa Clara Valley in San Benito County and in most areas where unconsolidated sediments and a high water table coincide. Liquefaction has been reported from historical earthquakes near San Juan Bautista and Hollister (San Benito County, 2015b).

Slope Stability

Slope instability occurs in areas with steep topography, as well as near Hollister, Tres Pinos and Paicines, and along faults (see Figure 26). Landslides can occur due to specific events, such as loss of vegetation after fires or earthquakes adding loads to barely stable slopes.

Subsidence

Areas susceptible to subsidence in San Benito County are typically composed to open textured soils that become saturated or extensive withdraw of groundwater or oil. Subsidence as a result of ground water mining has been well documented in the Santa Clara Valley to the north. Cases of subsidence within the County have not been well documented. Subsidence in the Santa Clara Valley is mainly due to hydrocompaction from groundwater withdrawal. The valley deposits within the
County are also at risk for subsidence if groundwater overdraft conditions exist (San Benito County, 2015b).

c. **Santa Cruz County**

Santa Cruz County is bounded to the north by San Mateo County, to the east by the crest of the Santa Cruz Mountains, to the south by the Pajaro River and to the west by the Pacific Ocean. The County is characterized by steep coastal bluffs and deep mountain canyons.

**Geologic Formations**

The Santa Cruz Mountains consist of predominantly marine sedimentary rocks of Paleocene to Pliocene age and non-marine sediments of Pleistocene and Holocene age, which overlay a granitic and metamorphic basement from the Cretaceous period or older (SCCRTC 2013).

**Earthquake Ground-shaking and Fault Rupture**

The major faults in Santa Cruz County are the San Andres Fault, the Zayante-Vergeles Fault, San Gregorio Fault, and the Monterey Bay – Tularcitos Fault Zone. These faults are associated with Holocene activity (movement in the last 11,000 years) and are considered to be active (SCCRTC 2013) (Figure 27). Southwest of the San Andreas Fault, the older sedimentary rocks in the Coast Ranges are moderately to strongly deformed, with steep-limbed folds and several generations of faults associated with uplift of the Santa Cruz Mountains. Along the coast, the ongoing tectonic activity is most evident in the gradual uplift of the coastline, as indicated by the series of uplifted marine terraces that sculpt the coastline (City of Santa Cruz 2011).

Although a map of ground-shaking hazards is not available for Santa Cruz County, the County of Santa Cruz Local Hazard Mitigation Plan 2015-2020 states that, based on historical evidence, the entire County is vulnerable to ground-shaking from earthquakes (Santa Cruz County 2015). The epicenter of the Loma Prieta earthquake in October 1989, which was the most intense to strike California since 1906, was located on the San Andreas Fault, approximately 10 miles east-northeast of the City of Santa Cruz.

**Liquefaction and Lateral Spreading**

Liquefaction and lateral spreading potential in Santa Cruz County is high in lowland areas of the City of Santa Cruz, the Soquel Valley and the Pajaro River Valley (Santa Cruz County 2015a). Specifically in areas of loose sand and silt that is saturated with water, soils can behave like liquid during earthquakes. Liquefaction can cause serious damage to foundations and bases of structures (USGS n.d.).

**Slope Stability**

Areas subject to landslide hazards are widely dispersed across inland portions of Santa Cruz County (Santa Cruz County 2015a).

**Expansive Soils**

Expansive soils occur in southeastern Santa Cruz County and along the coast, especially in the City of Santa Cruz and in Capitola (Santa Cruz County 2015a).
Subsidence

Santa Cruz County does not have any areas that have a high susceptibility to subsidence. Estimated potential for areas within the county that are at a low susceptibility to subsidence include the coastal areas of the County as well as inland toward the middle of the County (California Department of Water Resources 2014).

d. Regulatory Setting

State

The Alquist-Priolo Earthquake Fault Zoning Act, California’s Alquist-Priolo Act (PRC 2621 et seq.), is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (Earthquake Fault Zones). It also defines criteria for identifying active faults, giving legal weight to terms such as “active,” and establishes a process for reviewing building proposals in and adjacent to Earthquake Fault Zones. Under the Alquist-Priolo Act, faults are zoned, and construction along or across them is strictly regulated if they are “sufficiently active” and “well-defined.” A fault is considered sufficiently active if one or more of its segments or strands shows evidence of surface displacement during Holocene time (defined as within the last 11,000 years). A fault is considered well-defined if its trace can be clearly identified by a trained geologist at the ground surface or in the shallow subsurface, using standard professional techniques, criteria and judgment (Hart and Bryant, 1997).

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong ground-shaking, liquefaction and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the State is charged with identifying and mapping areas at risk of strong ground-shaking, liquefaction, landslides and other corollary hazards, and cities and counties are required to regulate development within mapped Seismic Hazard Zones.

The California Building Standards Code (CBSC) is based on the Uniform Building Code (International Code Council 1997), which is used widely throughout United States and has been modified for California conditions with numerous, more detailed or more stringent regulations. The CBSC provides standards for various aspects of construction, including, but not limited to: excavation, grading and earthwork construction; fills and embankments; expansive soils; foundation investigations; and liquefaction potential and soil strength loss. In accordance with California law, proponents of specific projects are required to comply with all provisions of the CBSC for certain aspects of design and construction.

The California Department of Transportation (Caltrans) has Seismic Design Criteria (SDC) which contain new and currently practiced seismic design and analysis methodologies for the design of new bridges in California. The SDC adopts a performance based approach specifying minimum levels of structural system performance, component performance, analysis and design practices for ordinary standard bridges. The SDC has been developed with input from the Caltrans Offices of Structure Design, Earthquake Engineering and Design Support and Materials and Foundations. Memo 20-1 outlines the bridge category and classification, seismic performance criteria, seismic
design philosophy and approach, seismic demands and capacities on structural components and seismic design practices that collectively comprise Caltrans’ seismic design methodology.

Section 402 of the Clean Water Act authorizes the California State Water Resources Control Board (SWRCB) to issue National Pollutant Discharge Elimination System (NPDES) General Construction Storm Water Permit (Water Quality Order 99-08-DWQ, as amended), referred to as the “General Construction Permit.” Construction activities can comply with and be covered under the General Construction Permit provided that the permittee:

- Develops and implements a Storm Water Pollution Prevention Plan (SWPPP) which specifies Best Management Practices (BMPs) that will prevent all construction pollutants from contacting stormwater and with the intent of keeping all products of erosion from moving off-site into receiving waters.
- Eliminates or reduces non-stormwater discharges to storm sewer systems and other waters of the nation.
- Performs inspections of all BMPs

Local

Monterey County

The Safety Element of the Monterey County General Plan (Monterey County, 2010a) contains and goals and policies related to seismic hazards. Goal S-1 of the General Plan is to “Minimize the potential for loss of life and property resulting from geologic and seismic hazards.” The policies listed under Goal S-1 would ensure that land uses contain measures to reduce loss from earthquakes (Policy S-1.1), site specific geologic studies for new development (Policy S-1.3) and require development review (Policy S-1.7) (Monterey County 2010b). Monterey County Code Chapter 16.12 is designed to eliminate and prevent conditions of accelerated erosion. The chapter requires control of all existing and potential conditions of accelerated erosion and sets forth required provisions for project planning, preparation of erosion control plans, runoff control and land clearing.

San Benito County

The Health and Safety Element of the San Benito County 2035 General Plan (San Benito County, 2015a) contains and goals and policies related to seismic and geological hazards. Goal HS-3 is to “protect lives and property from seismic and geologic hazards.” Policies listed under this goal include earthquake resistant design (Policy HS-3.1), abatement of unsafe structures (Policy HS-3.4), liquefaction studies (Policy HS-3.8) and seismic safety evaluations (Policy HS-3.9) (San Benito County, 2015a). Chapter 19.17 of the San Benito County Code of Ordinances requires erosion control as part of project plans that include the proposed methods for control of runoff, erosion and sediment control.

Santa Cruz County

The Health, Safety and Noise Element of the Santa Cruz County General Plan and Local Coastal Program (Santa Cruz County, 1994) contains objectives and policies related to seismic hazards. Goal 6.1 is to “reduce the potential for loss of life, injury and property damage resulting from earthquakes by regulating the siting and design of development in seismic hazard areas; encouraging open space; agricultural or low density land use in the fault zones; and increasing
public information and awareness of seismic hazards” (Santa Cruz County, 1994). Policies in the General Plan to implement this objective include geological review for development in designated fault zones (Policy 6.1.1), site investigation regarding liquefaction hazard (Policy 6.1.4) and location of new development away from potentially hazardous areas (Policy 6.1.5). Similar to the Monterey County Code, the Santa Cruz County Code Chapter 16.22 is designed to prevent accelerated erosion. Under Section 16.22.040 of the Santa Cruz County Code no personal shall allow for the continued existence of accelerated erosion. Chapter 16.22 requires projects to have an erosion control plan, runoff control and land clearing approval.

Many cities within the AMBAG region have similar geology and soils and seismic hazard goals and policies in their respective general plans.

4.7.2 Impact Analysis

a. Methodology and Significance Thresholds

Appendix G of the State CEQA Guideline identifies the following criteria for determining whether a project’s impacts would have a significant impact related to geology and soils:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground-shaking, seismic-related ground failure, including liquefaction, or landslides;
2. Result in substantial soil erosion or the loss of topsoil;
3. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
4. Be located on expansive soil, creating substantial risks to life or property; and/or
5. 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 wastewater.

Projects under the 2040 MTP/SCS would not require the use of septic tanks and land use projects would likely to connect to existing facilities. Therefore, Threshold 5 is discussed in Section 4.16, Less Than Significant Environmental Factors.

b. Project Impacts and Mitigation Measures

This section describes generalized impacts associated with the 2040 MTP/SCS. Table 29 summarizes the specific projects that could result in the impacts discussed in this section. Due to the programmatic nature of the 2040 MTP/SCS, a precise, project-level analysis of the specific geologic impacts associated with individual transportation and land use projects is not possible. Because the location of each proposed improvement can be different in geologic character, the ultimate determination of impact significance and identification of mitigation measures will be based on site-specific analysis at the time of the project design and environmental review. In general, however, implementation of proposed transportation improvements and future projects under the land use scenario envisioned by the 2040 MTP/SCS could be exposed to impacts caused by geology/soil conditions as described in the following sections.
Threshold 1: Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, strong seismic ground-shaking, seismic-related ground failure, including liquefaction, or landslides.

Impact GEO-1 IMPLEMENTATION OF PROPOSED TRANSPORTATION IMPROVEMENTS AND FUTURE PROJECTS INCLUDED IN LAND USE SCENARIO ENVISIONED IN THE 2040 MTP/SCS COULD BE SUBJECT TO SEISMIC HAZARDS, INCLUDING FAULT RUPTURE, GROUND-SHAKING, LIQUEFACTION AND LANDSLIDING, THAT COULD EXPOSE PEOPLE OR STRUCTURES TO SUBSTANTIAL ADVERSE EFFECTS. IMPACTS WOULD BE SIGNIFICANT BUT MITIGABLE.

Fault rupture can occur along or immediately adjacent to faults during an earthquake. Fault rupture is characterized by ground cracks and displacement which could endanger life and property. Damage is typically limited to areas close to the moving fault.

Ground-shaking effects are also the result of an earthquake, but the impacts can be widespread. Although a function of earthquake intensity, ground-shaking effects can be magnified by the underlying soils and geology, which may amplify shaking at great distances. It is difficult to predict the magnitude of ground-shaking following an earthquake, as shaking can vary widely within a relatively small area.

As indicated by Table 29, transportation projects across the AMBAG region may be vulnerable to fault rupture. Roadway projects near faults in Monterey County include roadway widening at SR-1 and Imjin Bridge as well as interchange improvements on SR 1 from Seaside to Sand City. In San Benito County, the proposed widening of SR 156 from San Juan Bautista to Union Road may be vulnerable to fault rupture associated with the San Andreas Fault.

Regional trail projects, due to their length, could be affected by faults. The proposed San Benito River Recreational Trail would cross the Calaveras fault zone. In addition, the Monterey Bay Sanctuary Scenic Trail Network, which would traverse coastal Santa Cruz County, would be vulnerable to the San Gregorio Fault in its northern reach.

Whereas vulnerability to fault rupture is site-specific, the entire planning area – and thus all projects under the 2040 MTP/SCS – would be vulnerable to ground-shaking. Transportation projects in the urbanized areas of northern Monterey County and southern Santa Cruz County (near the epicenter of the Loma Prieta earthquake) would be particularly susceptible to ground-shaking (Monterey County Multi-Jurisdictional Hazard Mitigation Plan 2014). Bridge structures are most susceptible to earthquake ground-shaking and fault rupture, although residential and commercial structures, as well as roadways, may also be damaged by either phenomenon.

Seismic related ground failure such as liquefaction or landslides may result from an earthquake in the AMBAG region. Projects in the Salinas River valley in Monterey County; greater Hollister area in San Benito County; and the Soquel Valley and Pajaro River Valley in Santa Cruz County are particularly susceptible to liquefaction. Roadway projects in mountainous areas or along steeply sloped streambanks are most susceptible to landslide or mudflows which may be triggered during an earthquake. Therefore, 2040 MTP/SCS projects such as the Union Road Construction (SB-COH-A11) may be impacted by seismic related ground failure.

Potential structural damage and the exposure of people to the risk of injury or death from structural failure would be minimized by compliance with California Building Code engineering design and construction measures. Foundations and other structural support features would be designed to
Mitigation Measures

For transportation projects under their jurisdiction, TAMC, SBtCOG and SCCRTC shall implement, and transportation project sponsor agencies can and should implement, the following mitigation measures developed for the 2040 MTP/SCS program where applicable for applicable transportation projects that could expose people or structures to substantial adverse effects due to seismic hazards. Cities and counties in the AMBAG region can and should implement these measures, where relevant to land use projects implementing the 2040 MTP/SCS. Project-specific environmental documents may adjust these mitigation measures as necessary to respond to site-specific conditions.

GEO-1 Geotechnical Design

If a 2040 MTP/SCS project is located in a zone of high potential ground-shaking intensity, implementing agencies can and should complete a site specific geotechnical report conducted by a qualified geotechnical expert. Any investigations shall comply with the California Geological Survey’s Guidelines for Evaluating and Mitigating Seismic Hazards in California and projects shall comply with the recommendations stated in the geotechnical analysis (California Geological Survey 2008). Recommendations may include, but are not limited to, the following: fill placement and compaction, isolated and continuous footing, site specific pipe bedding and site specific seismic design criteria.

Implementing Agencies

Implementing agencies for AMBAG transportation projects include RTPAs and transportation project sponsor agencies. Implementing agencies for land use projects include cities and counties.

Significance After Mitigation

Implementation of the above measure would reduce impacts to a less than significant level because site-specific geotechnical engineering would be required consistent with existing regulations to ensure that proposed facilities and structures would be designed in such a way that ground shaking and seismic-related ground failure would not expose people or structures to substantial adverse effects.

Threshold 2:  Result in substantial soil erosion or the loss of topsoil

Impact GEO-2  GRADING ASSOCIATED WITH TRANSPORTATION IMPROVEMENTS AND FUTURE PROJECTS INCLUDED IN THE LAND USE SCENARIO ENVISIONED IN THE 2040 MTP/SCS COULD CAUSE SOIL EROSION AND LOSS OF TOP SOIL. HOWEVER, COMPLIANCE WITH APPLICABLE REGULATIONS WOULD ENSURE THAT IMPACTS WOULD REMAIN LESS THAN SIGNIFICANT.

Typically, erosion and loss of top soil resulting from grading and development occur on a very small scale and do not present a quantifiable threat to a community. However, erosion and grading also have the potential to create unstable slopes and significant loss of topsoil can occur for projects.
where excavations require off-site soil disposal. Erosion control can be accomplished on critical slopes being affected by natural agents. Buildout under the 2040 MTP/SCS would occur in conformance with the Monterey County Code, Chapter 16.12 Erosion Control; San Benito County Code of Ordinances, Chapter 19.17 Grading, Drainage and Erosion Control; and Santa Cruz County Code, Chapter 16.22 Erosion Control, as discussed in the Regulatory Setting. These ordinances would require the appropriate measures to prevent erosion as a result of implementation of transportation and land use projects under the 2040 MTP/SCS, thus reducing erosion impacts.

In addition, the Regional Water Quality Control Board would require a project-specific SWPPP to be prepared for each project that disturbs an area one acre or larger. The SWPPPs would include project-specific BMPs designed to control drainage and erosion. Project BMPs to control erosion may include, but would not be limited to: silt fencing, fiber rolls, slope stabilization and sand bags. These BMPs would be required as part of each individual project permit and would minimize impacts related to soil erosion and loss of top soil as a result of construction or grading.

Adherence to the applicable ordinance codes and other local, State and local regulatory programs, as discussed above, would ensure that project-specific erosion and topsoil loss would be minimized. Because such effects would not be substantial, impacts related to erosion and loss of topsoil would be less than significant.

**Mitigation Measures**

None required.

<table>
<thead>
<tr>
<th>Threshold 3:</th>
<th>Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold 4:</td>
<td>Be located on expansive soil, creating substantial risks to life or property</td>
</tr>
</tbody>
</table>

**Impact GEO-3 IMPLEMENTATION OF PROPOSED TRANSPORTATION IMPROVEMENTS AND FUTURE PROJECTS INCLUDED IN THE LAND USE SCENARIO ENVISIONED IN THE 2040 MTP/SCS COULD BE LOCATED ON POTENTIALLY UNSTABLE SOILS OR IN AREAS OF LATERAL SPREADING, SUBSIDENCE, OR HIGH LIQUEFACTION POTENTIAL. IMPACTS WOULD BE SIGNIFICANT BUT MITIGABLE.**

Implementation of proposed transportation improvements and future projects under the land use scenario envisioned by the 2040 MTP/SCS could be prone to slope instability, liquefaction and other soil-related hazards. Representative projects that could be subject to these hazards are listed in Table 29.

As discussed above, Monterey County is vulnerable to slope instability in the Santa Lucia Mountain Range and fault zones; San Benito County is vulnerable to slope instability near Hollister, Tres Pinos and Paicines; and Santa Cruz County is vulnerable to slope instability across inland portions of Santa Cruz. Erosion problems are generally limited to restricted areas where grading has over-steepened slopes, has deposited fill in unstable areas, or where improper grading practices have not included provisions to seed or otherwise protect fresh slopes from eroding. Due to areas susceptible to slope instability in the Monterey Bay region, erosion will continue to reduce slopes to lower and lower elevations. However, this normal function is incremental and slow enough so as to be imperceptible. This can change if the erosion functions are accelerated by events, predominantly human activities related to development and grading. Roadway projects in mountainous areas or along steeply sloped streambanks are most susceptible to landslide or mudflows, especially when soils are wet...
and in areas adjacent to unstabilized cut or fill. Few projects proposed under the 2040 MTP/SCS are located in such areas. However, projects involving cut slopes of over 20 feet in height or projects located in areas of bedded or jointed bedrock are more likely to result in a landslide. Impacts related to landslides are significant.

New development that is constructed on expansive soils could be subject to damage or could become unstable when the underlying soil shrinks or swells. Soils with high clay content have the highest potential for shrink-swell. Potential impacts related to expansive soils may occur in coastal areas of southern Santa Cruz County and in the Pajaro River valley. Transportation improvement projects in the 2040 MTP/SCS which may be affected include the Branciforte Creek Bike and Pedestrian Crossing. However, expansive soils can be remediated or structures and foundations can be engineered to withstand the forces of expansive soil. Impacts related to soil expansion would be significant for 2040 MTP/SCS projects in these areas.

Transportation improvements and new development constructed under the 2040 MTP/SCS may be vulnerable to subsidence to in areas with saturation. Within the AMBAG region, these areas include the Carmel Valley and Salinas Valley in Monterey County and valley areas under conditions of overdraft in San Benito County. Santa Cruz County has low potential for subsidence. Where it can occur, subsidence may result in unstable soils and the affect the stability of structures constructed by the 2040 MTP/SCS. Therefore, projects under the 2040 MTP/SCS may be located on unstable soils with potential for subsidence and impacts would be significant.

Transportation improvements and development projects emphasized in the 2040 MTP/SCS may be vulnerable to liquefaction and lateral spreading in areas with younger soils and with high groundwater tables. In the AMBAG region, these areas include the Salinas River Valley in Monterey County; greater Hollister area in San Benito County; and the City of Santa Cruz, the Soquel Valley and the Pajaro River Valley in Santa Cruz County. Liquefaction and resulting lateral spreading may result in the loss of the soils ability to support structures constructed by the 2040 MTP/SCS in any of these areas. Liquefaction and lateral spreading impacts would be significant.

Mitigation Measures

For transportation projects under their jurisdiction, TAMC, SBtCOG and SCCRTC shall implement, and transportation project sponsor agencies can and should implement, the following mitigation measures developed for the 2040 MTP/SCS program where applicable for transportation projects that could be located on unstable soils or in areas of high liquefaction potential. Cities and counties in the AMBAG region can and should implement these measures, where relevant to land use projects implementing the 2040 MTP/SCS. Project-specific environmental documents may adjust these mitigation measures as necessary to respond to site-specific conditions.

GEO-3(a) Geotechnical Analysis

If a 2040 MTP/SCS project is located in an area of moderate to high liquefaction, lateral spreading and/or subsidence potential or in underground areas located in an area of high groundwater potential, the RTPAs shall ensure and sponsor agencies can and should ensure that these structures are designed based upon site specific geology, soils and earthquake engineering studies conducted by a qualified geotechnical expert. Projects shall follow the recommendations of these studies. Possible design measures include, but would not be limited to: deep foundations, removal of liquefiable materials and dewatering.
Implementing Agencies
Implementing agencies for transportation projects include RTPAs and transportation project sponsor agencies. Implementing agencies for land use projects include cities and counties.

GEO-3(b) Hillside Stability Evaluation
If a 2040 MTP/SCS project requires cut slopes over 20 feet in height or is located in areas of bedded or jointed bedrock, the implementing agency shall ensure that hillside stability evaluations and/or specific slope stabilization studies are conducted by a qualified geotechnical expert. Projects shall follow the recommendations of these studies. Possible stabilization methods include buttresses, retaining walls and soldier piles.

Implementing Agencies
Implementing agencies for transportation projects include RTPAs and transportation project sponsor agencies. Implementing agencies for land use projects include cities and counties.

GEO-3(c) Site Specific Geotechnical Evaluation
If a 2040 MTP/SCS project is located in an area of highly expansive soils, the RTPAs shall and sponsors agencies can and should ensure that a site-specific geotechnical investigation is conducted. The investigation shall identify hazardous conditions and recommend appropriate design factors to minimize hazards. Such measures could include concrete slabs on grade with increased steel reinforcement, removal of highly expansive material and replacement with non-expansive import fill material, or chemical treatment with hydrated lime to reduce the expansion characteristics of the soils.

Implementing Agencies
Implementing agencies for transportation projects include RTPAs and transportation project sponsor agencies. Implementing agencies for land use projects include cities and counties.

Significance After Mitigation
Implementation of the above measures would reduce impacts to a less than significant level because individual projects would require geotechnical analysis when located on potentially unstable soils. Site specific geotechnical evaluations and hillside stability evaluation would identify feasible measures to address site specific issues related to unstable soils and geologic hazards and reduce geological hazards impacts to less than significant levels.

c. Specific 2040 MTP/SCS Projects that May Result in Impacts
Table 29 identifies projects that may result in geology and soils-related impacts as discussed above. Given the large number of projects proposed across the AMBAG region in the 2040 MTP/SCS, the table shows a representative rather than comprehensive list of project that would generate these impacts. Listed projects are representative of the types of geologic impacts and the types of transportation projects that could be affected in different localities.

The individual projects listed could result in significant geologic impacts but would not necessarily do so. Additional site-specific analysis will need to be conducted as the individual projects are implemented in order to determine the project-specific magnitude of impact. Mitigation measures discussed above would apply to these specific projects as well as any other 2040 MTP/SCS projects that would result geology and soils-related impacts.
### Table 29  2040 MTP/SCS Projects that May Result in Geologic Impacts

<table>
<thead>
<tr>
<th>AMBAG Project No.</th>
<th>Projects</th>
<th>Location</th>
<th>Impact</th>
<th>Description of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>MON-CT011-CT</td>
<td>SR 68 Commuter Improvements</td>
<td>Monterey</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-CT030-SL</td>
<td>U.S. 101 Salinas Corridor</td>
<td>Salinas</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-CT015-CT</td>
<td>SR 1 Seaside to Sand City</td>
<td>Monterey</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-MAR001-MA</td>
<td>Marina – Salinas Corridor</td>
<td>Marina</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-SMS090-SL</td>
<td>Russel Road Extension</td>
<td>Salinas</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-FRAN018-SE</td>
<td>Giggling Road</td>
<td>Seaside</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>MON-KCY035-CK</td>
<td>Multimodal Transportation Center</td>
<td>King City</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
<tr>
<td>SB-CT-A01</td>
<td>SR 156 Widening – San Juan Bautista to Union Road</td>
<td>San Juan Bautista</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking and liquefaction</td>
</tr>
<tr>
<td>SB-SBC-A65</td>
<td>San Benito River Recreational Trail Phase I</td>
<td>San Benito County</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking and liquefaction</td>
</tr>
<tr>
<td>SB-COG-A54</td>
<td>SR 25 Corridor Improvements Project</td>
<td>San Benito County</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking and liquefaction</td>
</tr>
<tr>
<td>SB-COH-A11</td>
<td>Union Road (formally Crestview Drive) Construction</td>
<td>Hollister</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking and liquefaction</td>
</tr>
<tr>
<td>SB-SJB-A08</td>
<td>Lavanigno Drive Construction</td>
<td>San Juan Bautista</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking and liquefaction</td>
</tr>
<tr>
<td>SC-RTC-24e-RTC</td>
<td>3 – Highway 1: Auxiliary Lanes from Park Avenue to Bay Avenue/Porter Street</td>
<td>Capitola</td>
<td>G-1, G-3</td>
<td>Potential impacts from ground-shaking, expansive soil</td>
</tr>
<tr>
<td>SC-RTC-27a-RTC</td>
<td>Monterey Bay Sanctuary Scenic Trail Network – Design, Environmental Clearance and Construction</td>
<td>Santa Cruz County</td>
<td>G-1, G-3</td>
<td>Potential impacts from fault rupture, ground-shaking, liquefaction, expansive soils</td>
</tr>
<tr>
<td>SC 465C</td>
<td>Branciforte Creek Bike/Pedestrian Crossing</td>
<td>Santa Cruz</td>
<td>G-1, G-3</td>
<td>Potential impacts from ground-shaking, liquefaction</td>
</tr>
<tr>
<td>SC-SV-27-SCV</td>
<td>Mount Hermon Road/Scotts Valley Drive/Whispering Pines Drive Intersection Operations Improvement Project</td>
<td>Scotts Valley</td>
<td>G-1</td>
<td>Potential impacts from ground-shaking</td>
</tr>
</tbody>
</table>
d. Cumulative Analysis

Geology, soils and seismicity impacts may be related to: increased exposure to seismic hazards, increased erosion and/or loss of topsoil, the presence of unstable/expansive soils and alternative waste disposal or septic systems. These effects occur independently of one another, and are caused by site-specific and project-specific characteristics and conditions. In addition, existing regulations, such as the California Building Code, specify mandatory actions that must occur during project development, which would minimize effects from construction and operation of projects related to geology, soils and seismicity as discussed above. Cumulative impacts related to geology, soils and seismicity would not be significant, and the 2040 MTP/SCS would not make a cumulatively considerable contribution to significant cumulative impacts related to geology, soils and seismicity.
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