3.8 GEOLOGY, SEISMICITY, AND MINERAL RESOURCES

This section evaluates the potential impacts related to geology and seismicity resulting from the implementation of the proposed Plan. In addition to regional geologic and seismic hazards, the potential effects related to mineral resources and local hazards, such as risks related to underlying geologic materials and soils, are also evaluated. The effects of erosion on water quality are addressed in Section 3.10, “Hydrology and Water Quality.”

Comments received in response to the Notice of Preparation (NOP) included a request for analysis of future housing in liquefaction zones (see Section 3.8.3, “Impact Analysis”) and ensuring sufficient water supply for fire-fighting following a major earthquake. Water supply availability is addressed in Section 3.14, "Public Utilities and Facilities."

The CEQA Guidelines note that comments received during the NOP scoping process can be helpful in “identifying the range of actions, alternatives, mitigation measures, and significant effects to be analyzed in depth in an EIR and in eliminating from detailed study issues found not to be important” (CEQA Guidelines Section 15083). Neither the CEQA Guidelines nor the statutes require a lead agency to respond directly to comments received in response to the NOP, but they do require that they be considered. Consistent with these requirements, the comments received in response to the NOP have been carefully reviewed and considered by MTC and ABAG in the preparation of the impact analysis in this section. Appendix B includes all NOP comments received.

3.8.1 Environmental Setting

REGIONAL GEOLOGY

The State of California has eleven natural geologic regions, known as geomorphic provinces, which are defined by the presence of similar physical characteristics, such as relief, landforms, and geology (CGS 2002). The majority of the nine-county San Francisco Bay Area is located within what is known as the Coast Range geomorphic province, with eastern portions of Solano, Contra Costa, and Alameda Counties extending into the neighboring Great Valley geomorphic province located east of the Coast Ranges.

Coast Range Province

The Coast Range is a geologically complex province that extends 400 miles along the Pacific Coast, from Oregon south into southern California. The Coast Range province is characterized by a series of northwest-trending ridges and valleys that run roughly parallel to the San Andreas fault zone and can be further divided into the northern and southern ranges, which are separated by San Francisco Bay. The San Francisco Bay is a broad, shallow regional structural depression created from an east-west expansion between the San Andreas and the Hayward Fault Systems. In the southern Bay Area, the Santa Cruz Mountains border San Francisco Bay on the west, while the Berkeley Hills, an extension of the Diablo Range, are to the east. Mount Diablo marks the northern end of the Diablo Range, which stretches 130 miles southward to the Kettleman Hills at the cusp of the San Joaquin Valley. The broad, low-relief Santa Clara and San Benito Valleys lie between the Santa Cruz Mountains and the Diablo Range. In the North Bay, the rugged, mountainous character of the Marin Peninsula is dominated by Mount Tamalpais (elevation 2,604 feet above sea level).

Much of the Coast Range province is composed of marine sedimentary and volcanic rocks that form the Franciscan Assemblage, located east of the San Andreas Fault. The Franciscan Assemblage in this region of California is approximately 65–150 million years old and consists primarily of greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments. The region west of the San Andreas Fault is underlain by a mass of basement rock known as the Salinian Block that is composed mainly of marine sandstone (up to 65 million years old) and various metamorphic rocks[1] believed to have originated some 350 miles to the south. The Salinian Block has been moving northward along the west side of the San Andreas Fault, and associated rocks can be found as far north as Point Arena, on the Mendocino County coast.

Marginal lands surrounding San Francisco Bay consist generally of alluvial plains of low relief that slope gently bayward from the bordering uplands and foothills. The alluvial plains that make up the bay margin are composed of alluvial sediments (up to two million years old) consisting of unconsolidated stream and basin deposits. These alluvial plains terminate bayward at the tidal marshlands that immediately surround the bay. Marshlands are composed of intertidal deposits, including widely found, fine-grained plastic clays commonly referred to as bay mud, which, in some areas, underlies artificial fills. Historic shoreline reclamation projects beginning at the turn of the 20th century have resulted in the placement of varying types of artificial fill that overlie intertidal deposits. San Francisco Bay is originally believed to have encompassed 700 square miles, although dredging and fill operations have reduced the extent of the bay to approximately 400 square miles.

Great Valley

Portions of Solano, Contra Costa, and Alameda Counties are in the Great Valley geomorphic province, which is characterized by a large, nearly level inland alluvial plain 400 miles in length and averaging 50 miles in width. The topography of the Great Valley is primarily flat, but it slopes gently along its eastern margin (Sierra Nevada foothills) and western margin (Coast Ranges). Sediments in the Great Valley consist of gravels, sands, clays, and silts that originated largely from the Sierra Nevada, with sediments from the Coast Ranges contributing to a lesser extent. The sediments that compose the valley floor are thick, in some areas extending as far as 10 miles below the surface. The Great Valley Sequence, a thick section of ancient sea floor sediments extending under the Great Valley, overlies the Coast Range Franciscan Assemblage along the valley's western flank.

SOILS

A wide variety of soils and soil types can be found throughout the nine-county Bay Area region. Soils in the Bay Area fall within four major classifications established by the U.S. Natural Resources Conservation Service. Depending on localized conditions, these general classifications are grouped into more specific soil types by location, climate, and slope. The Santa Clara Valley and the alluvial plains surrounding San Francisco Bay are classified as deep alluvial plain and floodplain soils. These soils occupy the valleys in areas with higher rainfall and are considered productive when drained and fertilized. Soils closer to the bay margin are generally dark-colored clays that have a high water table or are subject to flooding. Soils at the extreme edge of San Francisco Bay have a moderate to high content of soluble salts; these soils are referred to as alkali soils. Soils in northern San Mateo County, the eastern portion of San Francisco, and Marin County are classified as residual soils and are characterized by moderate depth to underlying bedrock. However, much of the Bay Area has been developed, and in urbanized areas, native soils are commonly no longer present or have been reworked and combined with imported fill materials over a long history of earthwork activities associated with development.

[1] Metamorphic rocks are sedimentary or volcanic rocks altered by prolonged heating and deformation.

Seismologists have observed differences in seismic shaking effects that are partially dependent on underlying soil deposits. Soft soils are known to amplify ground shaking and are considered in seismic design requirements. The National Earthquake Hazards Reduction Program (NEHRP) has defined five soil types based on several different criteria (Milsom and Eriksen 2011):

- **Soil Type A** includes unweathered intrusive igneous rock. Does not contribute greatly to shaking amplification.
- **Soil Type B** includes volcanics, most Mesozoic bedrock, and some Franciscan bedrock. Does not contribute greatly to shaking amplification.
- **Soil Type C** includes some Quaternary sands, sandstones and mudstones, some Upper Tertiary sandstones, mudstones and limestone, some Lower Tertiary mudstones and sandstones, and Franciscan melange and serpentinite. Can contribute to shaking amplification depending on site-specific characteristics.
- **Soil Type D** includes some Quaternary muds, sands, gravels, and silts. Significant amplification of shaking by these soils is generally expected.
- **Soil Type E** includes water-saturated mud and artificial fill. The strongest amplification of shaking is expected for this soil type.

SEISMICITY

The Bay Area is considered a region of high seismic activity with numerous active and potentially active faults capable of producing significant seismic events. An active fault is defined by the State of California as a fault that has had surface displacement within Holocene time (approximately the last 10,000 years). A potentially active fault is defined as a fault that has shown evidence of surface displacement during the Quaternary (last 1.6 million years) unless direct geologic evidence demonstrates inactivity for all of the Holocene or longer. This definition does not mean that faults lacking evidence of surface displacement are necessarily inactive. “Sufficiently active” is also used to describe a fault if there is some evidence that Holocene displacement occurred on one or more of its segments or branches (CGS 2018). The U.S. Geological Survey (USGS) Working Group on California Earthquake Probabilities has evaluated the probability of one or more earthquakes occurring in the Bay Area and concluded that there is currently a 72-percent likelihood of a magnitude 6.7 or higher earthquake occurring in the Bay Area over the 30-year period between 2014 and 2043 (USGS 2016). The Hayward, Calaveras, and San Andreas Faults are the three faults considered to have the highest probabilities of causing a significant seismic event in the Bay Area. These three faults are strike-slip-faults[2] that have experienced movement within the last 155 years.

The San Andreas Fault is a major structural feature in the region and forms a boundary between the North American and Pacific tectonic plates. Other principal faults capable of producing significant Bay Area ground shaking, listed in **Table 3.8-1** and shown in **Figure 3.8-1**, include the Hayward Fault, the Rodgers Creek–Healdsburg Fault, the Concord–Green Valley Fault, the Marsh Creek-Greenville Fault, and the West Napa Fault. A major seismic event on any of these active faults could cause significant ground shaking and surface fault rupture, as was experienced during earthquakes in recorded history, namely the 1868 Hayward earthquake, the 1906 San Francisco earthquake, and the 1989 Loma Prieta

[2] “Strike-slip” faults primarily exhibit displacement in a horizontal direction but may have a vertical component. During right-lateral strike-slip movement of the San Andreas Fault, for example, the western portion of the fault slowly moves north while the relative motion of the eastern portion is to the south.

earthquake. The estimated maximum moment magnitudes identified in **Table 3.8-1** represent *characteristic* earthquakes on particular faults.[3] In addition, active blind-thrust and reverse-thrust faults[4] in the region that accommodate compressional movement include the Monte Vista–Shannon and Mount Diablo Faults.

Table 3.8-1: Active Bay Area Faults

Fault	Recency of Movement	Historical Seismicity
Hayward	1868 Holocene	M7.0, 1868;
San Andreas	1989 Holocene	M6.9, 1989; M7.8, 1906; M7.4, 1838; Many < M6
Rodgers Creek- Healdsburg	1969 Holocene	M6.4, 1898; M5.6, M.7 1969
Concord–Green Valley	1955 Holocene	M5.4, 1955
Marsh Creek-Greenville	1980 Holocene	M5.4, 1980
San Gregorio–Hosgri	Holocene; Late Quaternary	Many M5.0 - M6.0
West Napa	2000 Holocene	M6.0, 2014; M5.0, 2000
Maacama	Holocene	Historic active creep
Calaveras	1984 Holocene	M6.2, 1984; Many < M5
Mount Diablo Thrust	Quaternary (possibly active)	N/A

Note: Magnitudes are shown in moment magnitude scale. Only the largest recorded earthquakes are listed.
Source: CGS 2021

GEOLOGIC AND SEISMIC HAZARDS

Surface Fault Rupture

Seismically induced ground rupture is defined as the physical displacement of surface deposits in response to an earthquake's seismic waves. The magnitude and nature of fault rupture can vary for different faults or even along different strands of the same fault. Future faulting is generally expected along different segments of faults with recent activity (CGS 2008). Structures and transportation and utility systems crossing fault traces are at risk during a major earthquake because of ground rupture caused by differential lateral and vertical movement on opposite sides of the active fault trace. Lateral displacement may range from a few inches to over 20 feet, as occurred in the 1906 San Francisco earthquake. Thrust faults, as well as faults with strike-slip movement, can have a vertical displacement component of several feet.

[3] Moment magnitude is related to the physical size of a fault rupture and movement across a fault, while Richter magnitude scale reflects the maximum amplitude of a particular type of seismic wave. Moment magnitude provides a physically meaningful measure of the size of a faulting event. The concept of "characteristic" earthquake means that we can anticipate, with reasonable certainty, the actual damaging earthquakes (the size of the earthquakes) that can occur on a fault.

[4] A reverse fault is one with predominantly vertical movement in which the upper block moves upward in relation to the lower block; a thrust fault is a low-angle reverse fault. Blind-thrust faults are low-angled subterranean faults that have no surface expression.

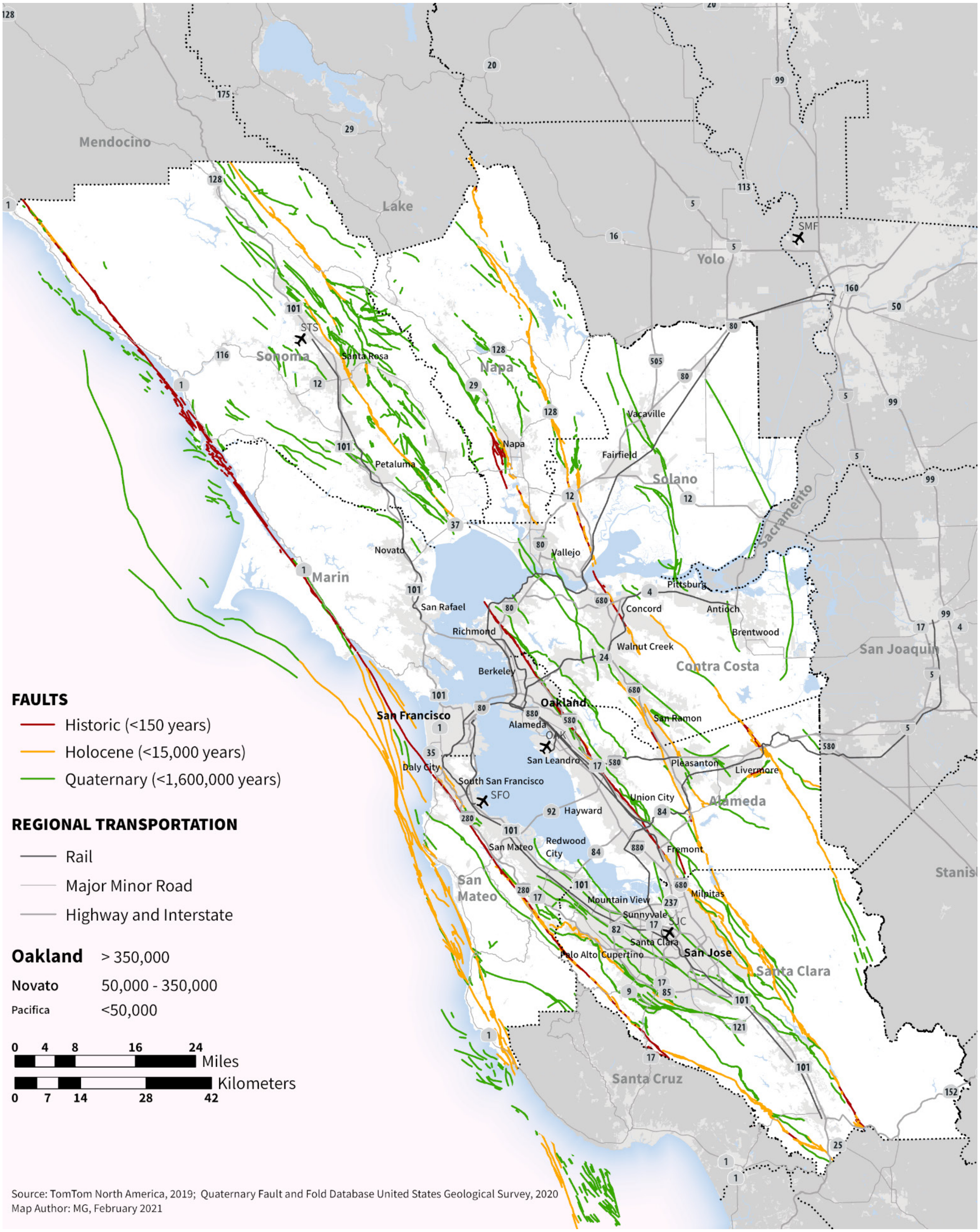

Figure 3.8-1: Principal Faults

The exception to obvious surface displacement is the "blind-thrust" fault. The Mount Diablo blind thrust fault has been mapped on the western base of Mount Diablo on the east side of the San Ramon Valley. This fault is considered a "blind thrust" because it does not exhibit a surficial expression of displacement. The Mount Diablo thrust fault slips at a long-term rate of about three millimeters per year, but it has not been zoned as an active fault under the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) because of the inability to identify its exact location on the surface (see description of the Alquist-Priolo Act in Section 3.8.2, "Regulatory Setting"). Although surface fault rupture could occur on any of the multiple active and potentially active faults located within the Bay Area, ground rupture is most likely to occur along active faults zoned as Earthquake Fault Zones under mandate of the Alquist-Priolo Act.

Ground Shaking

Strong ground movement from a major earthquake could affect the Bay Area during the next 30 years. Ground shaking may affect areas hundreds of miles distant from the earthquake's epicenter. The intensity of ground movement during an earthquake can vary depending on the overall magnitude, distance from the fault, direction of earthquake energy, and type of geologic material.

Areas that are underlain by bedrock tend to experience less ground shaking than those underlain by unconsolidated sediments, such as artificial fill. Particularly, unconsolidated sediments in areas located relatively distant from faults can intensify ground shaking. For example, the areas that experienced the worst structural damage further away from the Loma Prieta epicenter were those locations with soils that amplified the effects of ground shaking. The Modified Mercalli Intensity (MMI) scale (see **Table 3.8-2**) is a common measure of earthquake effects attributable to ground shaking intensity. The MMI values range from I (earthquake not felt) to XII (damage nearly total), and intensities as low as V could cause structural damage.[5]

Table 3.8-2: Modified Mercalli Intensity Scale

Intensity	Description
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck.
IV	Felt indoors by many, outdoors by a few. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Note: The original MMI scale goes to XII, but those values are no longer reported or described by the U.S. Geological Survey. The description was adapted slightly from the U.S. Geological Survey.
Source: USGS data compiled by MTC and ABAG in 2021 based on USGS 2020

[5] The damage level represents the estimated overall level of damage that will occur for various MMI levels. The damage, however, will not be uniform. Some structures will experience substantially more damage than this overall level, and others will experience substantially less damage. Not all structures perform identically in an earthquake. The age, material, type, method of construction, size, and shape of a structure all affect its performance.

Areas in the Bay Area most susceptible to intense ground shaking are those areas located closest to the earthquake-generating fault and areas underlain by thick, loosely unconsolidated, saturated sediments, particularly soft, saturated bay muds, and artificial fill along the tidal margins of San Francisco Bay. Probabilistic ground shaking is mapped in **Figure 3.8-2**. This map shows likely shaking intensity in the Bay Area in any 50-year period from all possible faults.

Liquefaction

Liquefaction is a phenomenon whereby unconsolidated and/or nearly saturated soils lose cohesion and are converted to a fluid state as a result of significant shaking. The relatively rapid loss of soil shear strength during strong earthquake shaking results in the temporary fluidlike behavior of the soil. Soil liquefaction causes ground failure that can damage roads, airport runways, pipelines, underground cables, and buildings with shallow foundations. Liquefaction can occur in areas characterized by water-saturated, cohesionless, granular materials at shallow depths, or in saturated unconsolidated or artificial fill sediments located in reclaimed areas along the margin of San Francisco Bay and along Bay Area river systems. Liquefaction potential is highest in areas underlain by shallow groundwater and bay fills, bay mud, and unconsolidated alluvium. **Figure 3.8-3** illustrates liquefaction susceptibility in the Bay Area.

Expansive Soils

Expansive soils possess a “shrink-swell” characteristic. Shrink-swell is the cyclic change in volume (expansion and contraction) that occurs in fine-grained clay sediments from the process of wetting and drying. Changes in soil moisture can result from rainfall, landscape irrigation, utility leakage, roof drainage, and/or perched groundwater. Perched groundwater is a local saturated zone above the water table that typically exists above an impervious layer (such as clay) of limited extent. Expansive soils are typically very fine grained and have a high to very high percentage of clay. Structural damage may occur incrementally over a long period of time, usually as a result of inadequate soil and foundation engineering or the placement of structures directly on expansive soils. Soils with high clay content, such as the bay muds located on the margins of the San Francisco Bay, are highly expansive.

Soil Erosion

Soil erosion is the process whereby soil materials are worn away and transported to another area, either by wind or water. Rates of erosion can vary depending on soil material and structure, building placement, and human activity. The potential for soil erosion is variable throughout the Bay Area. Soil with high amounts of silt can be easily eroded, while sandy soils are less susceptible to erosion. Excessive soil erosion can eventually damage building foundations, roadways, and dam embankments. Erosion is most likely on sloped areas with exposed soil, especially where unnatural slopes are created by cut-and-fill activities. Soil erosion rates can, therefore, be higher during the construction phase. Typically, the soil erosion potential is reduced once the soil is graded and covered with vegetation, concrete, structures, or asphalt.

Settlement

Settlement is the depression of the bearing soil when a load, such as that of a building or new fill material, is placed upon it. Settlement can occur from immediate settlement, consolidation, shrinkage of expansive soil, and liquefaction (discussed above). Immediate settlement occurs when a load from a structure or placement of new fill material is applied, causing distortion in the underlying materials. This settlement occurs quickly and is typically complete after placement of the final load. Consolidation settlement occurs in saturated clay from the volume change caused by squeezing out water from the pore spaces. Consolidation occurs over a period of time and is followed by secondary compression, which is a continued change in void ratio under the application of the load. Soils tend

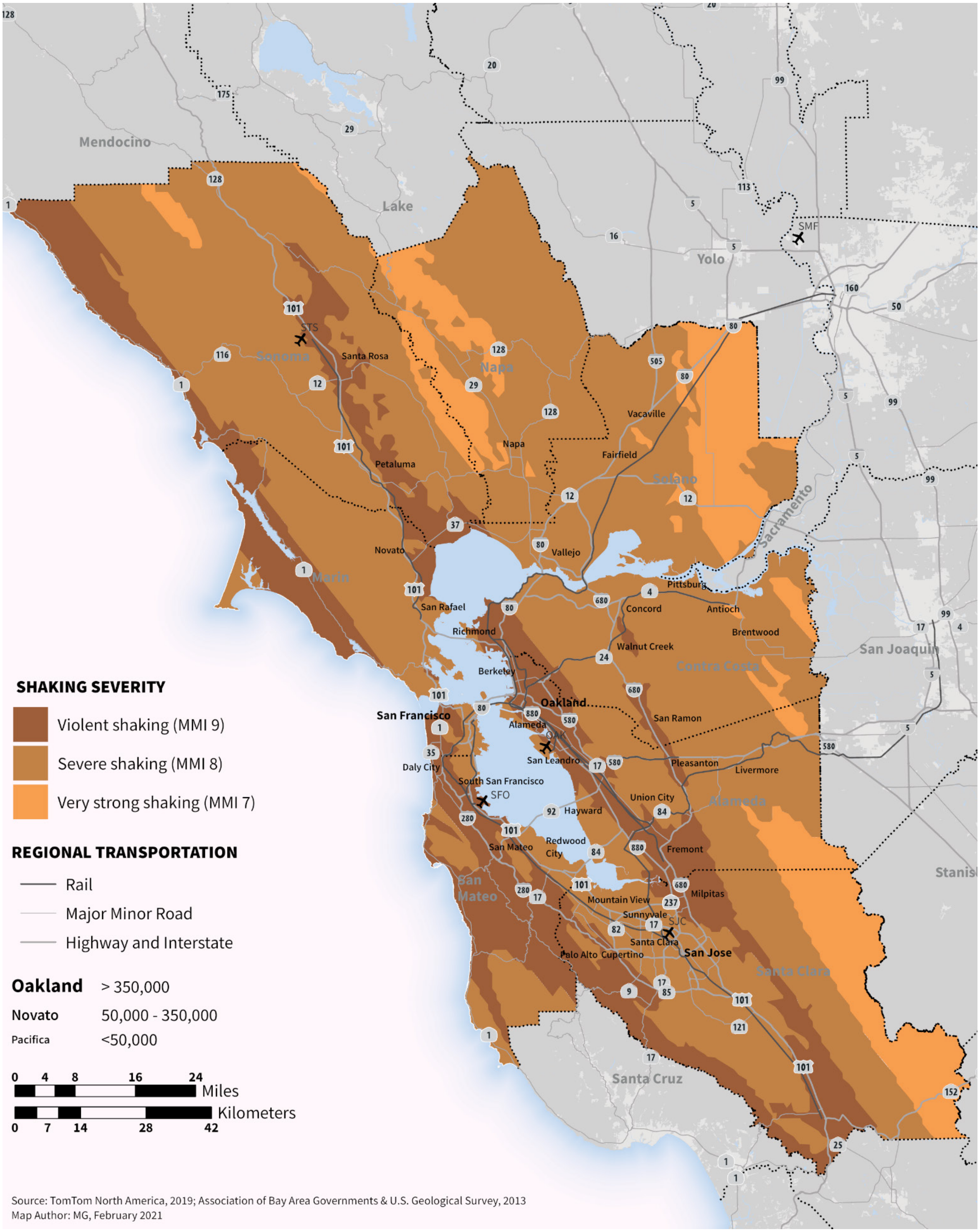

Figure 3.8-2: Ground Shaking Intensity

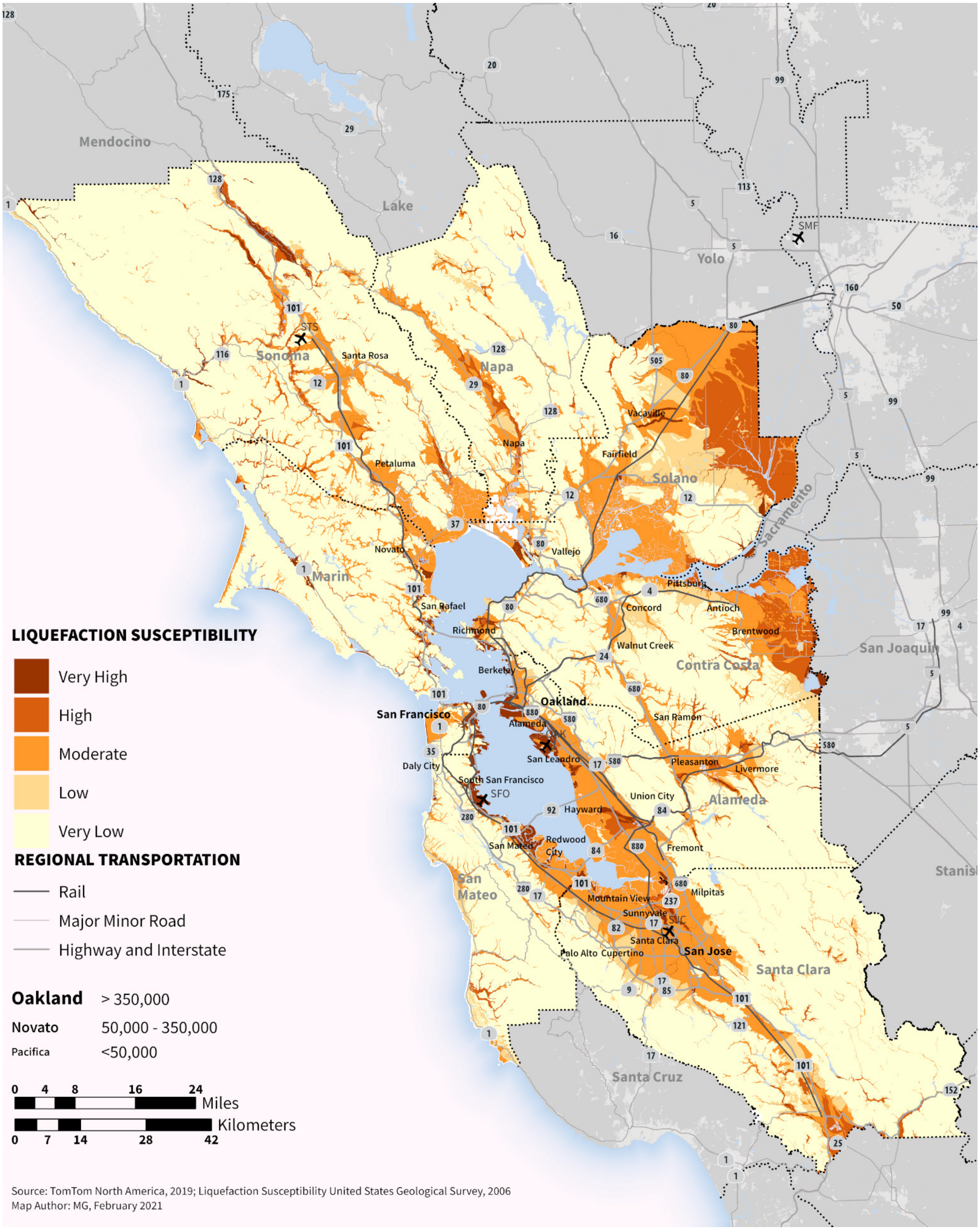

Figure 3.8-3: Liquefaction

to settle at different rates and by varying amounts, depending on the load weight, which is a phenomenon referred to as differential settlement. Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or the bay mud present in the marshland on the San Francisco Bay margin.

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid compaction and settling of subsurface materials (particularly loose, noncompacted, and variable sandy sediments) related to the rearrangement of soil particles during prolonged ground shaking. Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates).

Land Subsidence

Land subsidence can occur in areas experiencing significant declines in groundwater levels. When groundwater is extracted from aquifers in sufficient quantity, the groundwater level is lowered and the water pressure, which supports the sediment grains structure, decreases. In unconsolidated deposits, as aquifer pressures decrease, the increased weight from overlying sediments may compact the fine-grained sediments and permanently decrease the porosity of the aquifer and the ability of the aquifer to store water. In the Bay Area, historical land subsidence has been observed only in Santa Clara County. Nonetheless, contemporary groundwater management plans in the area address the potential for land subsidence (Valley Water 2021).

Landslides

Slope failures, commonly referred to as landslides, include many phenomena that involve the downslope displacement and movement of material, triggered either by static (i.e., gravity) or by dynamic (i.e., earthquake) forces. A slope failure is a mass of rock, soil, and debris displaced downslope by sliding, flowing, or falling. Exposed rock slopes undergo rockfalls, rockslides, or rock avalanches, while soil slopes experience shallow soil slides, rapid debris flows, and deep-seated rotational slides. Landslides may occur on slopes of 15 percent or less; however, the probability is greater on steeper slopes that exhibit old landslide features, such as scarps, slanted vegetation, and transverse ridges. Cutting into the slope and removing the lower portion, or slope toe, can reduce or eliminate the slope support, thereby increasing stress on the slope.

Landslide-susceptible areas are characterized by steep slopes and downslope creep of surface materials. Debris flows consist of a loose mass of rocks and other granular material that, if saturated and present on a steep slope, can move downslope. The rate of rock and soil movement can vary from a slow creep over many years to a sudden mass movement. Landslides occur throughout California, but the density of incidents increases in zones of active faulting.

Slope stability can depend on a number of complex variables. The geology, structure, and amount of groundwater in the slope affects slope failure potential, as do external processes (i.e., climate, topography, slope geometry, and human activity). The factors that contribute to slope movements include those that decrease the resistance in the slope materials and those that increase the stresses on the slope. Slope failure under static forces occurs when those forces initiating failure overcome the forces resisting slope movement. For example, a soil slope may be considered stable until it becomes saturated with water (e.g., during heavy rains or because of a broken pipe or sewer line). Under saturated conditions, the water pressure in the individual pores within the soil increases, reducing the strength of the soil. Areas mapped by USGS as subject to rain-induced landslide hazards are shown in **Figure 3.8-4**. Areas classified as Mostly Landslides consist of mapped landslides and intervening areas between groups of mapped landslides. The Many Landslides designation also consists of mapped landslides and more extensive intervening areas than Mostly Landslides areas. Areas classified as Few

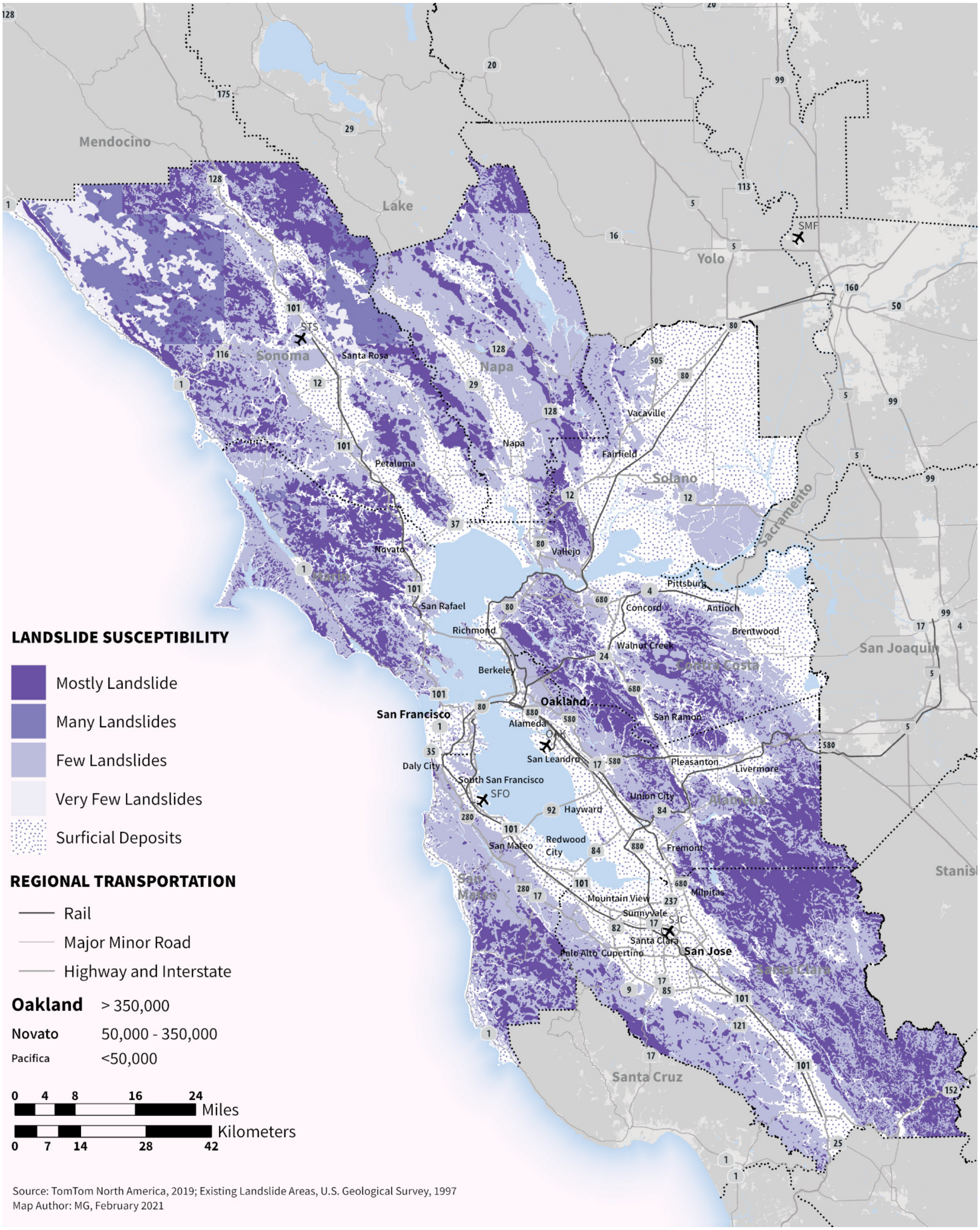

Figure 3.8-4: Landslides

Landslides contain few, if any, large, mapped landslides, but locally contains scattered small landslides and questionably identified larger landslides (USGS 1997).

Earthquake motions can induce significant horizontal and vertical dynamic stresses in slopes that can trigger failure. Earthquake-induced landslides can occur in areas with steep slopes that are susceptible to strong ground motion during an earthquake. Earthquake-induced landslide hazards have been mapped for only a portion of the Plan area. Where mapping is available, the hazard areas generally coincide with the areas mapped as Mostly, Many, and Few Landslides.

PALEONTOLOGICAL SETTING

Important vertebrate and invertebrate fossils and unique geologic units have been documented throughout California. The fossil yielding potential of a particular area is highly dependent on the geologic age and origin of the underlying rocks (refer to geologic timescale in **Table 3.8-3**). Paleontological potential refers to the likelihood that a rock unit will yield a unique or significant paleontological resource. All sedimentary rocks, some volcanic rocks, and some low-grade metamorphic rocks have potential to yield paleontological resources. Depending on location, the paleontological potential of subsurface materials generally increases with depth beneath the surface, as well as with proximity to known fossiliferous deposits.

Table 3.8-3: Divisions of Geologic Time

Era	Period	Time in Millions of Years Ago (approximately)	Epoch
Cenozoic	Quaternary	< 0.01	Holocene
		2.6	Pleistocene
	Tertiary	5.3	Pliocene
		23	Miocene
		34	Oligocene
		56	Eocene
		65	Paleocene
Mesozoic	Cretaceous	145	--
	Jurassic	200	--
	Triassic	251	--
Paleozoic	Permian	299	--
	Carboniferous	359	--
	Devonian	416	--
	Silurian	444	--
	Ordovician	488	--
	Cambrian	542	--
Precambrian		2,500	--

Source: USGS 2010

Pleistocene or older (older than 11,000 years) continental sedimentary deposits are considered to have a high paleontological potential while Holocene-age deposits (less than 10,000 years old) are generally considered to have a low paleontological potential because they are geologically immature and are unlikely to contain fossilized remains of organisms. Metamorphic and igneous rocks have a low paleontological potential, either because they formed beneath the surface of the earth (such as granite), or because they have been altered under high heat and pressures, chaotically mixed or severely fractured. Generally, the processes that form igneous and metamorphic rocks are too destructive to preserve identifiable fossil remains.

Paleontological Resources

A search of the University of California Museum of Paleontology (UCMP) database at UC Berkeley was conducted on April 12, 2021. Records of paleontological finds maintained by the UCMP (UCMP 2021) state that there are approximately 5,809 sites at which fossil remains have been found in the Bay Area, with the greatest concentration of 2,570 occurring in Contra Costa County. San Mateo County has the second highest number of paleontological sites at 924. **Table 3.8-4** shows a breakdown of these paleontological resources by epoch of each site.

Table 3.8-4: Bay Area Recorded Paleontological Sites

	Alameda County	Contra Costa County	Marin County	Napa County	San Francisco County	San Mateo County	Santa Clara County	Solano County	Sonoma County
Holocene	5	4	11	0	57	73	5	86	11
Pleistocene	74	73	24	1	36	120	19	12	15
Pliocene	8	88	52	4	16	222	7	5	81
Miocene	239	1,148	24	9	3	27	53	8	24
Oligocene	0	134	0	0	0	5	2	0	0
Eocene	42	577	0	2	0	101	9	119	1
Paleocene	2	223	0	1	0	5	11	8	7
Cretaceous	51	110	0	76	1	51	30	35	10
Jurassic	13	2	1	23	0	0	9	0	0
Recent	49	90	241	3	83	305	8	8	379
Unknown	50	121	16	24	32	15	38	16	26
Total	533	2,570	369	143	228	924	191	297	554

Note: Two periods are identified for some sites listed in the University of California 2021 source. In those cases, the more recent period is identified in this table.
Source: UCMP 2021

MINERAL RESOURCES

Most of the mineral resources in the Bay Area are located in the populated plains or valleys (rather than in the mountainous areas), which limits the potential for extraction. Nevertheless, substantial mineral resource extraction has occurred. More than 25 mineral commodities have been recovered in substantial quantities (USGS 1975).

Table 3.8-5 lists key mineral resources in the Bay Area. The major mineral resources recovered in the Bay Area are (1) construction materials, such as limestone and oyster shells (used in manufacture of cement), sand and gravel, and crushed stone; (2) energy sources, such as gas, oil, and geothermal power; and (3) salines. Historically, most mineral products have been used locally, fulfilling a need for low-cost construction materials and a supply of energy (USGS 1975).

Table 3.8-5: Bay Area Mineral Resources, by County

	Alameda County	Contra Costa County	Marin County	Napa County	San Francisco County	San Mateo County	Santa Clara County	Solano County	Sonoma County
Asbestos	X	X		X					
Chromite	X	X	X	X	X	X	X	X	X
Clay	X	X	X	X	X	X	X	X	X
Coal	X	X							
Copper	X	X	X	X			X		X
Diatomite		X		X					X
Expansible shale	X	X	X	X	X	X	X	X	X
Gemstones	X	X	X	X	X	X	X	X	X
Geothermal Resources				X					X
Limestone and shells	X	X	X	X		X	X	X	X
Magnesite	X			X			X		X
Manganese	X	X	X	X			X		X
Mercury	X	X	X	X	X	X	X	X	X
Mineral water		X	X	X		X	X		X
Oil and gas	X	X	X	X		X	X	X	X
Peat		X					X	X	
Pumice		X		X	X			X	X
Pyrite	X								
Salines	X		X	X		X	X	X	
Sand and gravel	X	X	X	X	X	X	X	X	X
Sands, specialty	X	X			X	X			
Silver				X					
Stone, crushed and broken	X	X	X	X	X	X	X	X	X
Stone, dimension	X	X	X	X	X	X	X	X	X
Stone, ornamental			X					X	
Sulfur, byproduct		X							

Source: USGS 1975

3.8.2 Regulatory Setting

FEDERAL REGULATIONS

Earthquake Hazards Reduction Act

The Earthquake Hazards Reduction Act was enacted in 1977 to "reduce the risks to life and property from future earthquakes in the United States through the establishment and maintenance of an effective earthquake hazards and reduction program." To accomplish this, the act established the National Earthquake Hazard Reduction Program (NEHRP). NEHRP's mission includes improved understanding and characterization of hazards and vulnerabilities, improvement of building codes and land use practices, risk reduction through post-earthquake investigations and education, development and improvement of design and construction techniques, improvement of mitigation capacity, development of alternative performance objectives to advance functional recovery, and accelerated application of research results. The NEHRP designates the National Institute of Standards and Technology as the lead agency of the program and assigns it several planning, coordinating, and reporting responsibilities. Programs under the NEHRP help inform and guide planning and building code requirements, such as emergency preparedness responsibilities and seismic code standards.

U.S. Geological Survey Landslide Hazard Program

The USGS Landslide Hazard Program provides information on landslide hazards, including information on current landslides, landslide reporting, real-time monitoring of landslide areas, mapping of landslides through the National Landslide Hazards Map, local landslide information, landslide education, and research.

Disaster Mitigation Act of 2000

The Disaster Mitigation Act of 2000 (DMA2K) (Public Law 106-390) amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 to establish a predisaster mitigation program and new requirements for the federal postdisaster Hazard Mitigation Grant Program. DMA2K encourages and rewards local and state predisaster planning. It seeks to integrate state and local planning with an overall goal of strengthening statewide hazard mitigation. This enhanced planning approach enables local, tribal, and state governments to identify specific strategies for reducing probable impacts of natural hazards, such as floods, fires, and earthquakes. To be eligible for hazard mitigation funding, local governments are required to develop a hazard mitigation plan that incorporates specific program elements of the DMA2K law. In the Bay Area, all counties and most cities have adopted local hazard mitigation plan updates. Some cities have individual plans, while some counties have developed multijurisdictional updates that include all or many of the cities in the county (FEMA 2020).

Disaster Recovery Reform Act of 2018

The Disaster Recovery Reform Act was signed into law in 2018. The reforms acknowledge the shared responsibility for disaster response and recovery, are intended to reduce the complexity of the Federal Emergency Management Agency (FEMA), and build the nation's capacity for the next catastrophic event. The law, which amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act, contains 56 distinct provisions that require FEMA policy or regulation changes for full implementation. Examples of the provisions include expanding eligible hazard mitigation activities including the replacement of electric utility poles resilient to extreme winds (Section 1204) and earthquake early warning technology (Section 1233).

Clean Water Act Section 402

Section 402 of the Clean Water Act (33 U.S. Code Section 1251 et seq.) establishes a framework for regulating municipal and industrial stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) program. The act is also directly relevant to excavation and grading. The NPDES program controls water pollution by regulating point sources that discharge pollutants, including rock, sand, dirt, and agricultural, industrial, and municipal waste, into waters of the United States. The U.S. Environmental Protection Agency has delegated to the State Water Resources Control Board the authority for the NPDES program in California, which is implemented by the State's nine regional water quality control boards (RWQCBs). Under the NPDES Phase II Rule, construction activity disturbing 1 or more acres must obtain coverage under the State's General Permit for Discharges of Storm Water Associated with Construction Activity (Construction Stormwater General Permit). As described further in Section 3.10, "Hydrology and Water Quality," the Construction Stormwater General Permit requires that applicants develop and implement a storm water pollution prevention plan (SWPPP), which specifies best management practices (BMPs) that reduce pollution in stormwater discharges to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology standards and require inspections and maintenance of all BMPs.

National Pollutant Discharge Elimination System

The NPDES program is a federal program for addressing discharges that adversely affect the quality of our nation's waters. NPDES stormwater permits are what regulate the implementation of controls designed to prevent harmful pollutants from being washed by stormwater runoff into local water bodies. Most states, including California, are authorized to implement the NPDES program and issue their own permits for stormwater discharges associated with construction activities. These permits generally can be thought of as umbrella permits that cover all stormwater discharges associated with construction activity for a designated period. Operators of individual construction sites then apply for coverage under the State's Construction Stormwater General Permit. In California, the Construction Stormwater General Permit (Order No. 2009-0009-DWQ) was issued by the State Water Resources Control Board and went into effect on July 1, 2010.

Dischargers whose projects disturb 1 or more acres of soil or whose projects disturb less than 1 acre but are part of a larger common plan of development that in total disturbs 1 or more acres are required to obtain coverage under the Construction General Permit. Construction activity subject to this permit includes clearing, grading, and creating disturbances to the ground, such as stockpiling or excavating, but it does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. The Construction General Permit requires the development of a SWPPP by a certified Qualified SWPPP Developer.

The California Green Building Code (CALGreen) requires the preparation of SWPPPs for projects that disturb less than 1 acre. CALGreen also requires postconstruction treatment control BMPs that improve stormwater runoff quality. It also requires that projects reduce peak runoff through the use of “low impact development” BMPs that indirectly reduce erosion.

International Building Code

The International Building Code (IBC) is published by the International Code Council, a nonprofit organization dedicated to developing a single set of comprehensive and coordinated national model construction codes. The IBC addresses health and safety concerns related to structural stability through prescriptive and performance-related requirements. California has used the IBC as the model code since January 1, 2008, using the 2006 IBC. The IBC is updated every three years, with the most recent version IBC 2018 effective in California on January 1, 2020.

STATE REGULATIONS

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act of 1972 (revised in 1994) is the State law that addresses hazards from earthquake fault zones and requires the delineation of zones along active faults. The purpose of this law is to mitigate surface fault rupture hazards by regulating development on or near active faults. As required by the act, the State has delineated Earthquake Fault Zones (formerly Special Studies Zones) along known active faults in California. Cities and counties must regulate certain development projects within these zones.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act was developed to protect the public from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and from other hazards caused by earthquakes. This act requires the State geologist to delineate various seismic hazard zones and requires cities, counties, and other local permitting agencies to regulate certain development projects within these zones. Before a development permit may be granted for a site within a Seismic Hazard Zone, a geotechnical investigation of the site must be conducted, and appropriate mitigation measures incorporated into the project design.

The Bay Area includes numerous Seismic Hazard Zones for liquefaction and earthquake-induced landslides, as designated by the California Geological Survey (CGS). Any projects in these designated zones require evaluation and mitigation of potential liquefaction or landslide hazards, which must be conducted in accordance with CGS Special Publication 117, adopted March 13, 1997, by the State Mining and Geology Board pursuant to the Seismic Hazards Mapping Act.

California Building Code

The California Building Code (CBC) has been codified in the CCR as Title 24, Part 2. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. The purpose of the CBC is to establish minimum standards to safeguard the public health, safety, and general welfare through structural strength, means of egress facilities, and general stability by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all building and structures within its jurisdiction. The 2019 CBC is based on the 2018 IBC published by the International Code Council. In addition, the CBC contains necessary California amendments, which are based on reference standards obtained from various technical committees and organizations, such as the American Society of Civil Engineers (ASCE), the American Institute of Steel Construction, and the American Concrete Institute. ASCE Minimum Design Standard 7-05 (ASCE 7-05) provides requirements for general structural design and includes means for determining earthquake loads, as well as other loads (e.g., flood, snow, wind), for inclusion into building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure, or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients that are used to determine a Seismic Design Category (SDC) for a project as described in Chapter 16 of the CBC. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E (very high seismic vulnerability and near a major fault) and SDC F (hospitals, police stations, emergency control centers in areas near major active faults). Design specifications are then determined according to the SDC in accordance with Chapter 16 of the CBC. Chapter 16, Section 1613 provides earthquake loading specifications for design and construction to resist the effects of earthquake motions in accordance with ASCE 7-05.

Chapter 18 of the CBC covers the requirements of geotechnical investigations (Section 1803); excavation, grading, and fills (Section 1804); load-bearing of soils (1806); foundations (Section 1808); shallow foundations (Section 1809); and deep foundations (Section 1810). Chapter 18 also describes analysis of expansive soils and the determination of the depth to groundwater table. For SDC D, E, and F, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses mitigation measures to be considered in structural design, which may include ground stabilization, selection of appropriate foundation type and depths, selection of appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. The potential for liquefaction and soil strength loss must be evaluated for site-specific peak ground acceleration magnitudes and source characteristics consistent with the design earthquake ground motions.

Specifically, Section 1803.7 of the CBC requires geologic and earthquake engineering reports for all proposed construction. The purpose of the engineering report is to identify geologic and seismic conditions that may require mitigation. The reports, which are prepared by a California certified engineering geologist in consultation with a California-registered geotechnical engineer, assess the nature of the site and potential for earthquake damage based on appropriate investigations of the regional and site geology, project foundation conditions, and potential seismic shaking at the site. These reports must consider the most recent CGS Note 48 (Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings), CGS Special Publication 42: Fault Rupture Hazard Zones in California (for project sites proposed within an Alquist-Priolo Zone), and the most recent version of CGS Special Publication 117: Guidelines for Evaluating and Mitigating Seismic Hazard in California (for project sites proposed within a Seismic Hazard Zone). All conclusions must be fully supported by satisfactory data and analysis.

The geotechnical report required by Section 1803 provides completed evaluations of the foundation conditions of the site and the potential geologic and seismic hazards. It includes site-specific evaluations of design criteria related to the nature and extent of foundation materials, groundwater conditions, liquefaction potential, and settlement potential and slope stability, as well as the results of the analysis of problem areas identified in the engineering geologic report. The geotechnical report incorporates estimates of the characteristics of site ground motion provided in the engineering geologic report. The geotechnical report must be prepared by a geotechnical engineer registered in the State of California with the advice of the certified engineering geologist and other technical experts, as necessary. The approved engineering geologic report is submitted with, or as part of, the geotechnical report. Local jurisdictions in the proposed Plan area typically regulate construction activities through a process that requires the preparation of a site-specific geotechnical investigation, consistent with Title 24, Part 2, Chapter 18 of the CBC.

CCR Title 24 also includes the California Residential Code and CALGreen, which have been adopted as separate documents (CCR Title 24, Part 2.5 and 11, respectively). CALGreen was the first State-mandated green building code in the nation. It establishes mandatory minimum green building standards and optional (more stringent) Tier 1 and Tier 2 provisions. Cities and counties have the discretion to adopt either tier as mandatory or to adopt their own more stringent standards. The green building standards included in CALGreen enhance the design and construction of buildings using planning and design concepts that reduce negative impacts on the environment through energy efficiency, water efficiency and conservation, and material conservation and resource efficiency. Sections 4.106.2 and 5.106.1 contain requirements intended to limit erosion related to development that would disturb less than one acre. The California Residential Code includes structural design standards for residential one- and two-family dwellings and covers all structural requirements for conventional construction. This part incorporates by adoption the 2009 International Residential Code of the International Code Council with necessary California amendments for seismic design. All other structures, including multifamily residential projects, are found in the other parts of the CBC, as discussed above.

California Department of Transportation Regulations and Seismic Design Criteria

The California Department of Transportation's (Caltrans's) jurisdiction includes rights-of-way (ROWs) of State and interstate routes within California. Any work within the ROW of a federal or State transportation corridor is subject to Caltrans regulations governing allowable actions and modifications. Caltrans issues permits to encroach on land within its jurisdiction to ensure that the encroachment is compatible with the primary uses of the State highway system, ensure safety, and protect the State's investment in the highway facility. The encroachment permit requirement applies to persons, corporations, cities, counties, utilities, and other government agencies. A permit is required for specific activities, including opening or excavating a State highway for any purpose, constructing or maintaining road approaches or connections, grading within ROWs on any State highway, and planting or tampering with vegetation growing along any State highway. The encroachment permit application requirements relating to geology, seismicity, and soils include information on road cuts, excavation size, engineering and grading cross-sections, hydraulic calculations, and mineral resources approved under the Surface Mining and Reclamation Act of 1975 (SMARA).

Caltrans Seismic Design Criteria (SDC) were established after past California earthquakes caused damage to older structures designed according to nonductile design standards. As a result, Caltrans initiated an extensive seismic retrofit program to strengthen the State's inventory of bridges to ensure satisfactory performance in future earthquakes. Caltrans has funded an extensive research program and developed design procedures that have furthered the state of practice of earthquake bridge engineering. The SDC are an encyclopedia of new and currently practiced seismic design and analysis methodologies for the design of new bridges in California. The SDC have a performance-based approach specifying minimum levels of structural system performance, component performance, analysis, and design practices for ordinary standard bridges. Bridges with nonstandard features or operational requirements above and beyond those of standard bridges may require a greater degree of attention than specified by the SDC.

California Surface Mining and Reclamation Act

SMARA mandated the initiation by the State geologist of mineral land classification to help identify and protect mineral resources in areas within the State subject to urban expansion or other irreversible land uses that would preclude mineral extraction. Areas are classified into mineral resource zones based on the presence of deposits and how much evaluation of the resource has occurred.

SMARA also allowed the State Mining and Geology Board (SMGB), after receiving classification information from the State geologist, to designate lands containing mineral deposits of regional or Statewide significance. Areas designated by SMGB are incorporated by regulation into Title 14, Division 2 of the CCR. Such designations require that a lead agency's land use decisions involving designated areas be made in accordance with its mineral resource management policies and that the lead agency consider the importance of the mineral resource to the region or the State as a whole and not just the lead agency's jurisdiction. In 1979, SMGB adopted guidelines for the management of mineral resources and preparation of local plans. The guidelines require local general plans to reference the State-identified mineral deposits and sites that are identified by the State geologist for conservation and/or future mineral extraction. Subsequently, SMGB identified urbanized areas where irreversible land uses precluded mineral extraction.

CGS has mapped mineral resource zones in parts of the Bay Area but has not created comprehensive digital maps for much of the Plan area.

REGIONAL AND LOCAL REGULATIONS

City and County General Plans

Safety elements are one of the seven required elements of a general plan listed in Section 65302 of the California Government Code. Among other mandatory topics, the safety element establishes policies and programs to protect the community from risks associated with seismic and geologic hazards. Every city and county must consult with CGS and the Office of Emergency Services before adopting or revising a safety element.

Hazard Mitigation Plans

As discussed above (see "Disaster Mitigation Act of 2000"), cities and counties in the Bay Area adopt hazard mitigation plans. Most communities are on their third or fourth update with the majority of jurisdictions covered by an annex to a multijurisdictional plan at the county level. Some Bay Area cities have a local hazard mitigation plan adopted specific to their jurisdiction.

Local Building Codes

Local building codes, like the CBC, are generally customized versions of the IBC. Local boards, councils, and assemblies may exclude portions of the standard codes or adopt more specific requirements to regulate individual land use for the health, safety, and general welfare of the people.

Local Grading and Erosion Control Ordinances

Most counties and cities in the Plan area have grading and erosion control ordinances. These ordinances control erosion and sedimentation caused by construction activities. A grading permit is typically required for construction-related projects. As part of the permit, project applicants are typically required to submit a grading and erosion control plan, vicinity and site maps, and other supplemental information. Standard conditions in the grading permit typically include a description of BMPs similar to those contained in a SWPPP.

3.8.3 Impact Analysis

SIGNIFICANCE CRITERIA

The following significance criteria are based on CEQA Guidelines Appendix G, the criteria used in the 2017 Plan Bay Area 2040 EIR, and professional judgment. Under these criteria, implementation of the proposed Plan would have a potentially significant adverse impact if it would:

- directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (Criterion GEO-1);
- directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking (Criterion GEO-2);
- directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction, lateral spreading, and subsidence (Criterion GEO-3);
- directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides (Criterion GEO-4);
- result in substantial soil erosion or the loss of topsoil (Criterion GEO-5);
- be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property (Criterion GEO-6);

- directly or indirectly destroy a unique paleontological resource or site or unique geologic feature? (Criterion GEO-7); or
- result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or a locally-important mineral resources recovery site delineated on a local land use plan (Criterion MR-1).

METHOD OF ANALYSIS

This program-level EIR evaluates potential impacts on geology, seismicity, and mineral resources based on the location of the proposed Plan's footprint associated with the forecasted development pattern (i.e., the land use growth footprint), sea level rise adaptation infrastructure (i.e., sea level rise adaptation footprint), and transportation projects (i.e., transportation system footprint) relative to the known distribution of geology, seismicity, and mineral resources throughout the Bay Area. The baseline for the following analysis reflects existing conditions when the EIR NOP was released in September 2020.

Quantitative results are presented for the region (i.e., the entire footprint, often summarized by county) and for the portions of the land use growth footprint specifically within transit priority areas (TPAs). TPAs are presented as a subset of the regional and county totals. Information provided by county includes both incorporated and unincorporated areas in the county.

For this impact assessment, a geographic information system (GIS) was used to digitally overlay the proposed Plan's footprints associated with forecasted land use development, sea level rise adaptation infrastructure, and transportation projects onto Alquist-Priolo fault zones from CGS, probabilistic earthquake shaking hazard zones from ABAG, and earthquake liquefaction susceptibility and rainfall induced landslide hazard zones from USGS. Because the effects of seismic activity and geological conditions would be primarily related to operational impacts (effects on buildings and infrastructure following construction) the impact discussions are not separated by construction and operation.

This evaluation of geological, seismic, and mineral resource impacts assumes that construction and development under the proposed Plan would adhere to applicable federal, State, and local regulations and would conform to appropriate standards in the industry, as relevant for individual projects. Where existing regulatory requirements or permitting requirements exist that are law and binding on responsible agencies and project sponsors, it is reasonable to assume that they would be implemented, thereby reducing impacts. For additional information on analysis methodology, refer to Section 3.1.3, "General Methodology and Assumptions."

IMPACTS AND MITIGATION MEASURES

Impact GEO-1: Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (LTS)

Land Use Impacts

Surface fault rupture could occur along any of the active fault traces or within the associated Alquist-Priolo Zone for the active faults within the proposed Plan area. Although fault rupture is not entirely confined to the boundaries of an Alquist-Priolo Zone, the zone represents the known areas with the highest likelihood of rupture occurring based on historical evidence and geologic records. The risk outside these zones is considered acceptable based on established State regulations, including California Building Code (CBC) requirements tied to seismic risk in building design, and is, therefore, not considered substantial for purposes of this analysis. The amount and location of surface displacement would depend on the magnitude and nature of the seismic event. In some cases, surface fault rupture can cause displacement of the ground surface, resulting in substantial damage to foundations, roadways, and utilities. Buried thrust faults and inferred faults are also located within the boundaries of the proposed Plan area; however, these fault types do not typically experience surface ruptures and are not officially recognized by the Alquist-Priolo Act. The proposed Plan's land use growth footprint includes a variety of land uses (e.g., residential and commercial) that could potentially be exposed to hazards as a result of surface fault rupture.

The acreage of the proposed Plan's land use growth footprint that either fully or partially intersect Alquist-Priolo Zones are listed below in **Table 3.8-6** delineating between acreage within TPAs for each county. Approximately 670 acres of the land use growth footprint is within an Alquist-Priolo Zone (**Table 3.8-6**). This includes TPAs in Alameda County (150 acres) and Contra Costa County (30 acres). TPAs in Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties are not located in Alquist-Priolo Zones; in other words, where the growth footprint within these counties overlaps with Alquist-Priolo Zones, these areas do not include any area identified as a TPA. Projects in TPAs that are located in delineated earthquake fault zones do not qualify for the exemption from CEQA review for sustainable community projects under PRC Section 21155.1 unless the applicable general plan or zoning ordinance contains provisions to mitigate the risk.

Table 3.8-6: Acreage of Land Use Growth Footprint within Alquist-Priolo Zones

County		Total (acres)
Alameda	County Total	210
	Within TPAs	150
Contra Costa	County Total	350
	Within TPAs	30
Marin	County Total	0
	Within TPAs	0
Napa	County Total	60
	Within TPAs	0
San Francisco	County Total	0
	Within TPAs	0
San Mateo	County Total	30
	Within TPAs	0
Santa Clara	County Total	4
	Within TPAs	0
Solano	County Total	20
	Within TPAs	0
Sonoma	County Total	1
	Within TPAs	0
Regional Total	County Total	670
	Within TPAs	170

Note: TPA acreages are a subset of county acreages. Whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10). Figures may not sum because of independent rounding.

Sources: Data compiled by MTC and ABAG in 2021 based on CGS 2019

Federal, State, and local laws, regulations, and programs in place and described herein avoid or reduce impacts from earthquakes and other seismic-related geologic hazards. To reduce impacts related to fault rupture, implementing agencies require project sponsors to comply with provisions of the Alquist-Priolo Act for project sites located within or across an Alquist-Priolo Zone. Lead agencies must prepare site-specific fault identification investigations conducted by licensed geotechnical professionals in accordance with the requirements of the Act, as well as any existing local policies that exceed or reasonably replace any of the Alquist-Priolo Act's requirements. Fault identification studies required by the Alquist-Priolo Act involve on-site trenching and excavation for site-specific identification and location of fault rupture planes where any future rupture would be anticipated. Structures intended for human occupancy (defined in the Act as a structure that might be occupied more than 2,000 hours per year) must be located a minimum distance of 50 feet from any identified active fault traces. All projects are required to adhere to design standards described in the CBC and all standard geotechnical investigation, design, grading, and construction practices to avoid or reduce impacts from earthquakes, ground shaking, ground failure, and landslides.

Regulatory agencies with oversight of development associated with the proposed Plan have developed regulations and engineering design specifications that address and substantially reduce hazards associated with site-level geological and seismic conditions. Therefore, the impact related to fault rupture hazards would be less than significant (LTS).

Sea Level Rise Adaptation Impacts

Surface fault rupture could cause ground surface displacement, resulting in substantial damage to sea level rise adaptation infrastructure. Different types of sea level rise adaptation infrastructure would have different levels of sensitivity to the ground surface displacement. Marsh systems would likely be largely unaffected by lateral deformation while elevated roadways or levee systems would require design considerations. The acreage of the proposed Plan's sea level rise adaptation infrastructure that either fully or partially intersect Alquist-Priolo Zones are listed below in **Table 3.8-7** by county. Similar to land use development and transportation projects, the design of sea level rise infrastructure in the Alquist-Priolo Zone would require site-specific investigations conducted by licensed geotechnical professionals to fully evaluate the level of potential damage from fault rupture. Depending on the agency with oversight for the infrastructure, construction and operation would be subject to applicable regulations from agencies such as the U.S. Army Corps of Engineers (USACE) or the California Department of Water Resources (DWR). USACE follows seismic standards like ASCE/SEI 7-10 to set the site class designation that infrastructure must be designed to, and DWR requires a 200-year return period ground motion analysis for the design of infrastructure like levees. DWR has also established the Urban Levee Design Criteria, which include criteria related to seismic vulnerability.

The potential for adverse fault impacts related to sea level rise projects from implementation of the proposed Plan would be less than significant (LTS).

Transportation System Impacts As noted above for the land use growth footprint, surface fault rupture could cause displacement of the ground surface, resulting in substantial damage to transportation projects including transit expansion projects, foundations, roadways, roadway interchanges, and utilities. Improvements associated with the transportation projects within the region would include a variety of different projects that could potentially be exposed to hazards as a result of surface fault rupture. There are approximately 250 acres associated with transportation projects that are within an Alquist-Priolo Zone and could be developed in conjunction with the proposed Plan (see **Table 3.8-8**).

Table 3.8-7: Acreage of Sea Level Rise Adaptation Footprint within Alquist-Priolo Zones

County	Total (acres)
Alameda	0
Contra Costa	10
Marin	6
Napa	0
San Francisco	0
San Mateo	0
Santa Clara	0
Solano	20
Sonoma	0
Regional Total	30

Note: Whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on CGS 2019

Table 3.8-8: Acreage of Transportation Projects Footprint within Alquist-Priolo Zones

County	Total (acres)
Alameda	180
Contra Costa	10
Marin	0
Napa	4
San Francisco	0
San Mateo	0
Santa Clara	0
Solano	50
Sonoma	0
Regional Total	250

Notes: Whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on CGS 2019

To reduce impacts related to fault rupture, implementing agencies require project sponsors to comply with provisions of the Alquist-Priolo Act for project sites located within or across an Alquist-Priolo Zone. Project sponsors must prepare site-specific fault identification investigations conducted by licensed geotechnical professionals in accordance with the requirements of the Act, as well as any existing local or Caltrans regulations and policies that exceed or reasonably replace any of the Act's requirements. Projects such as interchange improvements to existing roadways that are located within an Alquist-Priolo Zone would not result in a substantial change to the risk or hazard but would nonetheless be constructed following preparation of a required geotechnical investigation to fully evaluate the level of potential damage from fault rupture. The potential for adverse fault impacts related to transportation projects from implementation of the proposed Plan would be less than significant (LTS).

Conclusion

The land use development pattern, sea level rise adaptation infrastructure, and transportation project effects related to fault rupture hazards are site specific and dependent on the location of the individual projects in relation to the active fault traces. The Alquist-Priolo Act regulates where development and road projects can occur in relation to faults by requiring detailed fault identification studies and stipulating minimum setback requirements. Local agencies and Caltrans also have requirements to address impacts related to fault rupture. The potential for adverse fault impacts related to land use changes from implementation of the proposed Plan therefore would be **less than significant (LTS)** because there are the existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these conditions to an acceptable level.

Mitigation Measures

None required.

Impact GEO-2: Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking (LTS)

Land Use Impacts

According to modeling conducted by USGS in conjunction with CGS, the Bay Area has a nearly three in four chance of a magnitude 6.7 or greater earthquake over the next 30 years. The shaking intensity of the next significant earthquake depends on the causative fault and the distance to the epicenter, the magnitude, the duration of shaking, and the characteristics of the underlying geologic materials. The potential for damage or loss during an earthquake of this magnitude could be substantial, especially in non-retrofitted older structures and infrastructure that were constructed under less stringent building codes. As shown in **Figure 3.8-2**, the entire Bay Area is classified as potentially experiencing very strong to violent ground shaking (MMI 7-9). **Table 3.8-9**, below, quantifies the area within the land use growth footprint potentially subject to strong, very strong, or violent ground shaking based on this data.

Table 3.8-9: Acreage of Land Use Growth Footprint Subject to Ground Shaking

County		Strong – MMI 7 (acres)	Very Strong – MMI 8 (acres)	Violent – MMI 9 (acres)
Alameda	County Total	0	2,600	4,500
	Within TPAs	0	680	2,600
Contra Costa	County Total	300	8,100	1,300
	Within TPAs	20	1,100	230
Marin	County Total	0	1,100	140
	Within TPAs	0	390	80
Napa	County Total	< 1	790	0
	Within TPAs	0	70	0
San Francisco	County Total	0	2,500	990
	Within TPAs	0	1,700	980
San Mateo	County Total	0	1,200	1,500
	Within TPAs	0	490	830
Santa Clara	County Total	0	7,400	1,100
	Within TPAs	0	4,800	460
Solano	County Total	950	3,100	0
	Within TPAs	0	160	0
Sonoma	County Total	0	1,000	840
	Within TPAs	0	110	140
Regional Total	County Total	1,300	27,800	10,400
	Within TPAs	20	9,600	5,400

Note: TPA acreages are a subset of county acreages. Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC/ABAG in 2021; ABAG and USGS 2013

In general, ground shaking is more severe in softer sediments, such as alluvial deposits where surface waves can be amplified, causing a longer duration of ground shaking compared to bedrock materials. Areas where bedrock is exposed or located at relatively shallow depth tend to experience surface waves from an earthquake as more of a sharp jolt, compared to other areas. Areas located within or near the Bay shoreline where alluvial sediments tend to be thicker, especially in areas where un-engineered fill or loose alluvial materials are found, could experience considerable ground shaking.

To reduce impacts related to ground shaking, implementing agencies require project sponsors to comply with the applicable version of the CBC. Compliance with the regulatory requirements in the CBC and any applicable local ordinances and ensuring that structures are constructed in compliance with the law, is the responsibility of the project engineers and building officials (typically associated with the local jurisdiction). The geotechnical engineer, as a registered professional with the State of California, is required to comply with the CBC and local codes while applying standard engineering practice and the appropriate standard of care for the particular region in California.

Projected development must comply with Chapter 16, Section 1613 of the CBC, which provides earthquake loading specifications for structures and associated attachments that must also meet the seismic criteria of ASCE Standard 07-05. To determine seismic criteria for proposed improvements, geotechnical investigations would be prepared by State-licensed engineers and engineering geologists that provide recommendations for site preparation and foundation design, as required by Chapter 18, Section 1803 of the CBC. Geotechnical investigations would also evaluate hazards such as liquefaction, lateral spreading, landslides, and expansive soils in accordance with CBC requirements and CGS's Guidelines for Evaluating and Mitigation Seismic Hazards in California (Special Publication 117A, 2008), where applicable.

The geotechnical engineer is responsible for investigating the underlying soils and bedrock on a site and, if necessary, developing remedies to improve soil conditions based on standard engineering practices. The geotechnical investigation must characterize, log, and test soils and bedrock conditions and determine the response of those underlying materials to ground shaking generated during an earthquake. Seismic response to varying material types is particularly critical in the Plan area, where construction may occur over soft clay and fills at the San Francisco Bay margin. The geotechnical investigation and the recommendations developed during the investigation must be presented in a report, which is reviewed, signed, and stamped by the professional engineer in charge. Based on the site's geotechnical conditions, the geotechnical report must include methods and materials for all aspects of the site development, including the site preparation, building foundations, structural design, utilities, and sidewalks and roadways, to remedy any geotechnical conditions related to seismic impacts. Once finalized, the geotechnical report would be submitted to the local permitting agency for review and comment. The local building officials work with the applicant and the geotechnical engineer to resolve inconsistencies and ensure that the investigation complies with the CBC and local ordinances. In connection with grading, foundation, building, and other site development permits, the local jurisdiction reviews the geotechnical investigation and recommendations and imposes permit requirements based on the geotechnical recommendations and CBC provisions. Recommended corrective measures, such as structural reinforcement and replacing native soils with engineered fill, must be incorporated into project designs. Developments must also adhere to local building code requirements for seismic safety, which identify and require specified construction techniques that aid in structural resistance to ground shaking, as well as local general plans and zoning ordinances, where applicable policies exist.

As discussed above, State laws and local regulations require that potential seismic hazards be identified and remedied prior to construction. Reliable mechanisms are in place to enforce these regulations and the implementation of design strategies identified in required geotechnical investigations are anticipated to protect public health and safety from substantial risks through appropriate engineering practices. Therefore, the potential for adverse ground shaking impacts related to land use changes from implementation of the proposed Plan would be less than significant (LTS).

Sea Level Rise Adaptation Impacts

As mentioned above, softer soils result in stronger shaking during earthquakes, which is one reason why all sea level rise infrastructure sited around the bay and ocean shoreline is in the very strong and violent probabilistic earthquake shaking hazard zones (**Table 3.8-10**). Similar to land use and transportation projects, the design of sea level rise infrastructure would build off of site-specific investigations conducted by licensed geotechnical professionals for each individual project site. Engineering professionals would then use the site-specific information to design infrastructure to withstand the corresponding level of shaking. Sea level rise adaptation infrastructure may shore up existing shoreline infrastructure that was built before modern code, improving the seismic stability of flood protection assets that previously may have been more sensitive to earthquake shaking. The potential for adverse ground shaking impacts related to sea level rise projects from implementation of the proposed Plan would be less than significant (LTS).

Table 3.8-10: Acreage of Sea Level Rise Adaptation Footprint Subject to Ground Shaking

County	Strong – MMI 7 (acres)	Very Strong – MMI 8 (acres)	Violent – MMI 9 (acres)
Alameda	0	340	820
Contra Costa	0	230	40
Marin	0	420	400
Napa	0	0	<1
San Francisco	0	60	0
San Mateo	0	580	110
Santa Clara	0	590	110
Solano	0	600	80
Sonoma	0	0	170
Regional Total	0	2,800	1,700

Notes: Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on ABAG and USGS 2013

Transportation System Impacts

As noted above for the projected land use growth, an earthquake on any one of the active faults in the Bay Area region could cause a large degree of ground shaking, resulting in damage to transportation projects if they are not engineered appropriately. Further, the proposed transportation projects within the region would include a variety of transit modifications that could increase the number of people in transit corridors potentially exposed to ground shaking hazards. There are transportation projects totaling 420 acres located in areas of very strong ground shaking, 9,300 acres located in areas of severe ground shaking, and 4,200 acres in areas of violent ground shaking (see **Table 3.8-11**).

Seismic design criteria are required of all construction, including transportation projects, where adverse effects from ground shaking could occur. The most current applicable version of the CBC and local building standards require roadway projects to employ design standards that consider seismically active areas to safeguard against major structural failures or loss of life. Similarly, bridge and overpass design is required to comply with Caltrans' design criteria. Caltrans provides seismic design criteria for new bridges in California, specifying minimum levels of structural system performance, component performance, analysis, and design practices. Based on application of these requirements, the potential for adverse ground shaking impacts related to transportation projects would be less than significant (LTS).

Table 3.8-11: Acreage of Transportation Projects Footprint Subject to Ground Shaking

County	Strong – MMI 7 (acres)	Very Strong – MMI 8 (acres)	Violent – MMI 9 (acres)
Alameda	0	1,400	1,500
Contra Costa	220	1,400	420
Marin	0	160	30
Napa	0	160	3
San Francisco	0	500	70
San Mateo	0	780	840
Santa Clara	190	3,700	1,100
Solano	6	1,400	70
Sonoma	0	6	120
Regional Total	420	9,300	4,200

Notes: Whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on ABAG and USGS 2013

Conclusion

The proposed Plan would accommodate an increased population within the seismically active Plan area. The degree of risk associated with the specific land use development pattern, sea level rise adaptation infrastructure, and transportation projects is dependent on site-specific criteria, including the location of the projects in relation to the seismic event, underlying geologic materials, and magnitude of the event. Regulatory requirements exist that specify mandatory actions that must occur during project development to address these risks which exist across the entire proposed Plan area. These impacts would be **less than significant (LTS)** because there are existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these conditions to an acceptable level.

Mitigation Measures

None required.

Impact GEO-3: Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction, lateral spreading, and subsidence (LTS)

Land Use Impacts

Liquefaction typically occurs in areas underlain with loose, saturated, cohesion-less soils within the upper 50 feet of subsurface materials. These soils, when subjected to ground shaking, can lose their strength due to buildup of excess pore water pressure, causing them to function in a manner closer to a liquefied state. As shown in **Figure 3.8-3** and summarized below in **Table 3.8-12**, there are many areas throughout the Bay Area region that are prone to seismic-related ground failure.

Table 3.8-12: Acreage of Land Use Growth Footprint Susceptible to Liquefaction

County		Very Low Potential (acres)	Low Potential (acres)	Medium Potential (acres)	High Potential (acres)	Very High Potential (acres)
Alameda	County Total	840	430	4,700	360	750
	Within TPAs	110	320	2,500	30	370
Contra Costa	County Total	3,600	1,600	3,300	890	230
	Within TPAs	390	540	410	3	60
Marin	County Total	430	10	350	0	450
	Within TPAs	160	5	190	0	110
Napa	County Total	180	250	300	50	6
	Within TPAs	1	0	30	30	< 1
San Francisco	County Total	990	60	860	10	1,500
	Within TPAs	910	60	850	10	880
San Mateo	County Total	780	200	790	70	850
	Within TPAs	350	90	540	40	310
Santa Clara	County Total	180	690	6,100	940	590
	Within TPAs	30	220	4,300	470	300
Solano	County Total	1,100	1,300	1,400	0	250
	Within TPAs	10	80	30	0	30
Sonoma	County Total	420	140	1,100	100	60
	Within TPAs	10	< 1	220	10	3
Regional Total	County Total	8,500	4,700	19,000	2,400	4,700
	Within TPAs	2,300	1,300	9,000	600	2,100

Note: TPA acreages are a subset of County acreages. Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.

Sources: Data compiled by MTC and ABAG in 2021 based on USGS 2006

Ground failure, including liquefaction, lateral spreading, and subsidence, as a result of an earthquake could occur in the Plan area depending on the underlying conditions including ground water level, relative size of soil particles, and density of subsurface materials within 50 feet of ground surface. Damage from earthquake-induced ground failure associated with liquefaction, lateral spreading, and subsidence could be high in buildings with foundations not properly constructed for such hazards. The impacts from ground failure, including liquefaction, lateral spreading, and subsidence, from development of land uses associated with the proposed Plan would be addressed through site-specific geotechnical studies prepared in accordance with CBC requirements, the Seismic Hazards Mapping Act, and standard industry practices. The State provides guidance in CGS Special Publication 117A, which includes uniform guidelines for evaluating seismic hazards other than surface fault-rupture, as well as mitigation measure recommendations as required by PRC Section 2695(a). Chapters 6 and 7 of CGS Special Publication 117A provide standards for site evaluation and provide strategies that can be implemented to address liquefaction. These chapters also provide guidance to consider variations of liquefaction where soils laterally spread or subside. The guidance recommends that geotechnical evaluations determine the amount of liquefiable soil, which may provide an indication of the magnitude of subsidence and/or the presence of a gentle slope and open face, such as a river bank or shoreline, where lateral spreading can occur. The Seismic Hazards Mapping Act requires a geotechnical site-specific investigation before any parcel subdivisions or structure permits may be issued, to determine the strength of underlying soils or rock. Subsequent development (excavations, foundations, building frames, retaining walls, and other building elements) would be required to conform to the current seismic design provisions of the CBC to reduce potential losses from ground failure as a result of an earthquake. Section 1613 of the CBC states that projects located in liquefaction zones shall incorporate seismic design features into both grading and construction plans. Chapter 18 of the CBC includes the requirements of geotechnical investigations (Section 1803), as well as foundations (Section 1808). For SDC D, E, and F, Chapter 18 requires analysis of slope instability, liquefaction, and surface rupture attributable to faulting or lateral spreading, plus an evaluation of lateral pressures on basement and retaining walls, liquefaction and soil strength loss, and lateral movement or reduction in foundation soil-bearing capacity. It also addresses measures to be considered in structural design, which may include ground stabilization, selecting appropriate foundation type and depths, selecting appropriate structural systems to accommodate anticipated displacements, or any combination of these measures. These future projects would also be required to adhere to the local general plans and local building code requirements that contain seismic safety policies to resist ground failure through modern construction techniques. Therefore, the potential for adverse ground failure impacts related to accommodating future growth in the proposed Plan would be less than significant (LTS).

Sea Level Rise Adaptation Impacts

Liquefaction hazard is generally greatest along the San Francisco Bay shoreline and along existing and historic riverine systems. Lateral spreading occurs when liquefaction occurs in a location with a gentle slope and an open face, making many of the sea level rise adaptation footprints with liquefaction exposure a likely location for lateral spreading to occur if soils liquify. Ground failure associated with liquefaction could result in damage to sea level rise infrastructure if not engineered appropriately. Implementation of the proposed Plan could result in sea level rise adaptation infrastructure covering up to 90 acres of very low liquefaction hazard, 50 acres in areas classified as low liquefaction hazard, 2,400 acres in areas classified as medium liquefaction hazard, 60 acres in areas of high liquefaction hazard, and 1,600 acres in areas classified as very high liquefaction hazard (see **Table 3.8-13**). Sea level rise infrastructure would be constructed in compliance with applicable versions of local, State, and federal standards that regulate the infrastructure, such as the USACE or DWR standards and regulations. Design criteria would require employing geotechnical practices such as ground treatment, replacing existing soils with engineered fill, or using deep foundation systems. The appropriate design approach would be dependent upon the unique conditions for each segment of shoreline and the various adaptation project types. The potential for adverse ground failure impacts related to sea level rise projects from implementation of the proposed Plan would be less than significant (LTS).

Table 3.8-13: Acreage of Sea Level Rise Adaptation Footprint Susceptible to Liquefaction

County	Very Low Potential (acres)	Low Potential (acres)	Medium Potential (acres)	High Potential (acres)	Very High Potential (acres)
Alameda	<1	0	500	50	540
Contra Costa	4	20	90	1	140
Marin	60	0	410	5	280
Napa	-	0	<1	0	-
San Francisco	-	0	0	0	50
San Mateo	<1	0	420	0	230
Santa Clara	-	0	530	<1	100
Solano	20	30	360	0	230
Sonoma	9	10	110	3	30
Regional Total	90	50	2,400	60	1,600

Note: Numbers less than 1 are shown as “<1”; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on USGS 2006

Transportation System Impacts

Although regional mapping of areas considered to have higher liquefaction potential has been conducted throughout the Plan area, liquefaction hazards are generally determined on a site-specific basis. The areas that are exposed to liquefaction hazard may also have lateral spreading or differential settlement and subsidence concerns. Areas not at risk of liquefaction do not have lateral spreading potential. As noted above for development pursuant to the proposed Plan, ground failure associated with liquefaction could result in damage to transportation projects if not engineered appropriately. Improvements associated with the proposed transportation projects within the region would include a variety of transit and roadway modifications that could increase the number of people and transit corridors potentially exposed to liquefaction hazards. The proposed Plan could result in transportation projects covering 2,600 acres of very low liquefaction hazard, 2,000 acres in areas classified as low liquefaction hazard, 7,200 acres in areas classified as medium liquefaction hazard, 520 acres in areas of high liquefaction hazard, and 1,600 acres in areas classified as very high liquefaction hazard (see **Table 3.8-14**).

Table 3.8-14: Acreage of Transportation Projects Footprint Susceptible to Liquefaction

County	Very Low Potential (acres)	Low Potential (acres)	Medium Potential (acres)	High Potential (acres)	Very High Potential (acres)
Alameda	490	210	1,700	220	270
Contra Costa	780	440	680	40	60
Marin	30	0	110	1	40
Napa	90	10	50	< 1	2
San Francisco	180	20	130	0	250
San Mateo	180	90	570	3	770
Santa Clara	580	870	3,100	260	170
Solano	220	320	840	0	50
Sonoma	20	10	90	< 1	2
Regional Total	2,600	2,000	7,200	520	1,600

Note: Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on USGS 2006

Roadway projects must comply with the applicable version of the CBC and local building standards by employing geotechnical practices such as ground treatment, replacing existing soils with engineered fill, or using deep foundation systems to anchor improvements into more competent materials. Similarly, bridge and overpass design must comply with Caltrans design criteria. As stated above, Caltrans provides seismic design criteria for new bridges in California, specifying minimum levels of structural system performance, component performance, analysis, and design practices that would include minimizing damage that could be expected from potential ground failure hazards. Therefore, the potential for ground failure hazards, including liquefaction, lateral spreading, and subsidence, to result in adverse impacts related to the transportation projects would be less than significant (LTS).

Conclusion

Implementation of the land use development pattern, sea level rise adaptation infrastructure, and transportation projects would result in projects being constructed or redeveloped in areas that could be susceptible to ground failure due to liquefaction, lateral spreading, or subsidence. Ground failure hazards are dependent on site-specific conditions and other considerations, such as the severity of and duration of shaking in a seismic event. The impacts of ground failure, including liquefaction, lateral spreading, and subsidence on development of the land use development, sea level rise infrastructure, transportation projects in the proposed Plan would be addressed through site-specific geotechnical studies required by local jurisdictions in accordance with standard industry practices and State-provided guidance, such as CGS Special Publication 117A. In addition, development would conform to the current seismic design provisions of the IBC and CBC to reduce potential losses from ground failure as a result of an earthquake. Proposed projects would also adhere to local general plans and local building code requirements that contain seismic safety requirements to resist ground failure through modern construction techniques. Therefore, ground failure hazards related to liquefaction, lateral spreading, and subsidence would be **less than significant (LTS)** because there are existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these conditions to an acceptable level.

Mitigation Measures

None required.

Impact GEO-4: Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving landslides (LTS)

Land Use Impacts

The Plan area includes a wide range of topographical conditions, and landslide hazards vary from very low in low lying areas to very high in some upland areas, especially areas with slopes that exceed 15 percent. **Figure 3.8-4** shows areas throughout the region that are considered prone to rain-induced landslide hazards. The proposed Plan's strategies focus 67 percent of the land use growth footprint into the designated growth geographies; however, the remainder (33 percent) of the land use growth footprint is outside designated growth geographies but consistent with existing local land use plans (See Table 2-4). According to regional data, approximately 900 acres of the land use growth footprint are located in areas mapped as many landslides, and 5,500 acres are mapped as few landslides. **Table 3.8-15** summarizes the acreage of land use growth footprint within counties and TPAs (this number is a subset of the county total) within areas subject to landslides.

Existing slopes and slope stability are generally considered in local land use planning and zoning, and areas within landslide zones tend to be designated for uses other than development. Approvals of development projects in areas subject to slope failures are also generally contingent on geologic and engineering studies that define and delineate potentially hazardous conditions and recommend adequate mitigation. The Seismic Hazard Mitigation Act addresses landslide hazards from earthquake shaking, requiring site evaluation in areas identified by the State. Earthwork recommendations for improved slope stability follow adopted State standards, such as the Guidelines for Evaluating and Mitigation Seismic Hazards in California (CGS 2008); incorporate site-evaluation findings; and inform the eventual engineered design of slope stabilization systems and other designed infrastructure. These documents are checked by the appropriate building official or engineer and may be reviewed by other departments of the county or city to check compliance with the laws and ordinances under their jurisdiction.

Future proposed developments must also be consistent with the CBC and adhere to the requirements for structural design, special inspections, and soils and foundations contained in Chapters 16 through 18 of the code. Local general plans and local building codes also often contain development policies to avoid landslides through construction design and slope stabilization techniques. Because local jurisdictions require a site-specific geologic investigation and analysis in accordance with standard industry practices and State-provided guidance, such as CGS Special Publication 117A, to minimize risk associated with landslides and because new development would be subject to local building codes and the CBC, which require implementation of design standards, the potential for adverse landslide impacts related to land use changes from implementation of the proposed Plan would be a less-than-significant (LTS) impact.

Table 3.8-15: Acreage of Land Use Growth Footprint within Landslide Zones

County		Few (acres)	Many (acres)
Alameda	County Total	1,200	70
	Within TPAs	440	<1
Contra Costa	County Total	2,100	480
	Within TPAs	210	20
Marin	County Total	300	130
	Within TPAs	150	20
Napa	County Total	9	<1
	Within TPAs	<1	0
San Francisco	County Total	450	20
	Within TPAs	370	2
San Mateo	County Total	300	20
	Within TPAs	40	4
Santa Clara	County Total	190	4
	Within TPAs	20	<1
Solano	County Total	840	80
	Within TPAs	6	0
Sonoma	County Total	180	90
	Within TPAs	10	0
Regional Total	County Total	5,500	900
	Within TPAs	1,200	40

Note: TPA acreages are a subset of county acreages. Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on USGS 1997

Sea Level Rise Adaptation Impacts

Most of the sea level rise infrastructure is located on gently sloped terrain. **Table 3.8-16** summarizes the acreage of land use growth footprint within areas subject to landslides by county. Sea level rise infrastructure within landslide zones would follow the same process outlined in the "Transportation System Impacts" section, below, working with a geotechnical and engineering professional to identify slope stability hazards and slope stability measures that must be implemented to meet local, State, and federal standards. As noted above under "Land Use Impacts," there are existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with landslides. The Seismic Hazards Mapping Act requires a geotechnical site-specific investigation before any parcel subdivisions or structure permits are permitted. Subsequent development (excavations, foundations, building frames, retaining walls, and other building elements) would be required to conform to the current seismic design provisions of the CBC. DWR has established the Urban Levee Design Criteria, which include criteria related to landside slope stability and landslides. Therefore, the potential for adverse landslide impacts related to sea level rise adaptation projects would be a less-than-significant (LTS) impact because there are existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these conditions to an acceptable level.

Table 3.8-16: Acreage of Sea Level Rise Adaptation Footprint within Landslide Zones

County	Few (acres)	Many (acres)
Alameda	0	0
Contra Costa	0	0
Marin	70	4
Napa	0	0
San Francisco	<1	0
San Mateo	0	0
Santa Clara	0	0
Solano	30	0
Sonoma	0	0
Regional Total	100	4

Note: Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on USGS 1997

Transportation System Impacts

Of the transportation projects, 1,900 acres would be located in areas zoned few landslides and 310 acres would be located in areas zoned many landslides (see **Table 3.8-17**). Most of the transportation projects would be outside of landslide zones. Projects that would develop land identified as mostly landslides generally include construction of transportation system expansions, as well as corridor improvements. These hazards would generally be addressed through compliance with existing regulations, as discussed in the "Land Use Impacts" section, above. The Caltrans Seismic Design Criteria require Project Specific Design Criteria (PSDC) for any projects that coincide with additional seismic hazards, which include landslide. As part of the PSDC process, a seismic safety peer review team would be established to check project designs. Transportation projects would be required to identify potential slope stability hazards and provide slope stabilization measures to meet the applicable version of the CBC and local building standards by employing geotechnical practices such as use of retaining walls, setback requirements, and deep foundation systems. Incorporation of slope stability measures would be effective in minimizing landslide hazards on proposed transportation projects. Therefore, the potential for landslide impacts related to the transportation projects at the regional level would be less than significant (LTS).

Table 3.8-17: Acreage of Transportation Projects Footprint within Landslide Zones

County	Few (acres)	Many (acres)
Alameda	440	90
Contra Costa	660	50
Marin	20	30
Napa	40	10
San Francisco	90	0
San Mateo	30	10
Santa Clara	420	110
Solano	190	10
Sonoma	30	<1
Regional Total	1,900	310

Note: Numbers less than 1 are shown as "<1"; whole numbers have been rounded (between 0 and 10 to the nearest whole number, between 11 and 999 to the nearest 10, between 1,000 and 1,000,000 to the nearest 100). Figures may not sum because of independent rounding.
Sources: Data compiled by MTC and ABAG in 2021 based on USGS 1997

Conclusion

Landslide hazards are dependent on site-specific conditions, including the steepness of slopes, and other conditions such as, in the case of seismically induced landslides, the distance and magnitude of the seismic event. Implementation of the land use development pattern, sea level rise adaptation infrastructure, and transportation projects would result in projects being constructed or redeveloped in areas that could be susceptible to landslides. State and local standards have been developed to address this condition. Landslide hazards would have a **less-than-significant (LTS) impact** because there are existing requirements under federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these conditions to an acceptable level.

Mitigation Measures

None required.

Impact GEO-5: Result in substantial soil erosion or the loss of topsoil (LTS)

Land Use Impacts

Development associated with the proposed Plan would include earthwork activities that could expose soils to the effects of erosion or loss of topsoil. Once disturbed, either through removal of vegetation, asphalt, or demolition of a structure, stockpiled soils may be exposed to the effects of wind and water. Generally, earthwork and ground-disturbing activities, unless below minimum requirements, require a grading permit, compliance with which minimizes erosion, and local grading ordinances ensure that construction practices include measures to protect exposed soils such as limiting work to dry seasons, covering stockpiled soils, and use of straw bales and silt fences to minimize off-site sedimentation. Additional reports, such as a soil engineering report, engineering geology report, or plans and specifications for grading may be required by the local building or engineering departments, depending on the proposal. The application, plans, and specifications (if any) would be checked by the appropriate building official or engineer and may be reviewed by other departments of the county or city to ensure compliance with the laws and ordinances under their jurisdiction. Earthwork recommendations for improved erosion controls, based on site conditions, would be incorporated into the project construction documents.

Development that disturbs more than 1 acre is subject to compliance with a NPDES permit, including the implementation of BMPs, some of which are specifically implemented to reduce soil erosion or loss of topsoil, and the implementation of a SWPPP through the local jurisdiction. BMPs that are required under a SWPPP would include erosion prevention measures that have proven effective in limiting soil erosion and loss of topsoil. Projects that would disturb less than 1 acre would be subject to the CalGreen requirements related to stormwater drainage that have been designed to prevent or reduce discharges of sediments through BMPs that include on-site retention and filtration. Generally, once construction is complete and exposed areas are revegetated or covered by buildings, asphalt, or concrete, the erosion hazard is substantially eliminated or reduced.

Existing regulatory requirements specify mandatory and prescriptive actions that must occur during project development, and it is reasonable to assume compliance with existing regulations and permitting requirements of independent regulatory agencies to address potential project effects. Therefore, because there are regulations in place that would effectively reduce the potential for loss of topsoil or erosion impacts related to land use changes from implementation of the proposed Plan at the regional, local, and TPA level, there would be a less-than-significant (LTS) impact.

Sea Level Rise Adaptation Impacts

Sea level rise adaptation infrastructure would require the movement of large amounts of earthwork and ground-disturbing activities, which could result in erosion or loss of topsoil. The sea level rise adaptation infrastructure, including restored marshes and levees, would in many instances reduce erosion; however, the infrastructure could also result in erosion elsewhere. Additional hydromodification impacts are explored in Section 3.10, "Hydrology and Water Quality." Local, regional, State, and federal regulations and permit requirements will address potential project effects. As with land use development, earthwork activities for sea level rise adaptation infrastructure would be required to adhere to NPDES permit requirements for construction, as well as any local grading ordinance requirements that may include erosion prevention measures. One of the requirements of this permit is the implementation of nonpoint source control of stormwater runoff through the application of BMPs. Therefore, as described in the "Land Use Impacts" section, above, the potential for loss of topsoil or erosion impacts related to land use changes from implementation of the proposed Plan would result in a less-than-significant (LTS) impact.

Transportation System Impacts

Transportation projects within the region would also include earthwork activities that would disturb underlying soils during construction, potentially exposing them to erosion and loss of topsoil in the same manner discussed above for projected land use. Construction of additional lanes on freeways and other transportation facilities could result in loss of topsoil if work includes grading, trenching, excavation, or soil removal of any kind in an area not previously used as a paved transportation facility. As with land use development, earthwork activities for transportation projects would be required to adhere to NPDES permit requirements for construction, as well as any local grading ordinance requirements that may include erosion prevention measures. Throughout California, the RWQCBs set erosion control standards because one of the major effects of grading is sedimentation of receiving waters. These control standards are administered via the NPDES permit process for storm drainage discharge. One of the requirements of this permit is the implementation of nonpoint source control of stormwater runoff through the application of BMPs. A storm water pollution prevention plan (SWPPP) is required by the RWQCB to describe the BMPs that would control both the quality and amount of stormwater runoff on a project site. Transportation projects and development that would occur under the Plan would be required to comply with this process.

Incorporation of erosion control BMP measures, such as use of straw bales, inlet protective measures, silt fences, and construction scheduling, in accordance with grading codes and any revegetation requirements, would be effective in minimizing erosion hazards and loss of topsoil associated with transportation projects. Therefore, the potential for loss of topsoil or erosion impacts related to the transportation projects included in the proposed Plan is less than significant (LTS).

Conclusion

As noted above, construction associated with the land use development pattern, sea level rise adaptation infrastructure, and transportation projects would include ground disturbance that could expose underlying soils to the effects of erosion. Existing regulatory requirements specify mandatory actions that must occur during project development that would address this potential impact. Therefore, this impact is **less than significant (LTS)** because there are existing federal, State, and local regulations and oversight in place that would effectively reduce the inherent hazard associated with these activities to an acceptable level.

Mitigation Measures

None required.

Impact GEO-6: Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property (LTS)

Land Use Impacts

Soils with high percentages of clay can expand when wet, causing structural damage to surface improvements. These clay soils can occur in localized areas throughout the San Francisco Bay Area region, making it necessary to survey project areas prior to construction. Expansive soils are generally removed during foundation work to avoid structural damage. The majority of projected growth occurs in already developed areas where expansive soils may have already been removed. However, expansive soils may remain in many parts of the Plan area. Some land use development associated with implementation of the proposed Plan could be located on soils that exhibit expansive properties when exposed to varying moisture content over time that could result in damage to foundations, walls, or other improvements. Structures, including residential units and commercial buildings, could be damaged as a result of settlement or differential settlement where structures are underlain by materials of varying engineering characteristics.

All site designs would be reviewed and approved by the appropriate federal, State, and local agencies. Project-specific geotechnical investigations consistent with existing regulatory requirements would identify expansive soil conditions, which would be addressed through the integration of geotechnical site investigations that characterize the soil strength and profile before being incorporated into the design process for development projects. The site investigation would ensure site suitability for projects and inform any geotechnical measures to ensure long-term stability, ensuring that regional growth and land use changes on geologic units or soils that are expansive would not become unstable as a result of development. Compliance with CBC requirements and adherence to local building codes and ordinances would reduce hazards relating to expansive soils. The potential for expansive soils to result in adverse impacts related to land use changes from implementation of the proposed Plan at the regional, local, and TPA level would be a less-than-significant (LTS) impact.

Sea Level Rise Adaptation Impacts

As described above, the construction of new structures near or above unstable soil or geologic units would be largely addressed through the implementation of geotechnical recommendations in the planning and design process in accordance with local, State, and federal code and regulation requirements. Compliance with CBC requirements, adherence to local building codes and ordinances, as well as federal levee requirements, where relevant, would reduce hazards relating to expansive soils. Sea level rise adaptation infrastructure on roadways or highways subject to review by the Federal Highway Administration (FHWA) would also be subject to compliance with FHWA regulations and design guidelines. The potential for adverse impacts related to sea level rise projects from implementation of the proposed Plan would be less than significant (LTS).

Transportation System Impacts

Transportation projects within the planning area would include a variety of transit modifications that could be located on unstable soil or geologic units. In general, many of the transportation projects would be in areas where previous roads or other improvements have occurred, and unstable soils or geologic units would have been addressed at the time of construction. However, some may have been addressed under older code requirements that may not be as stringent as current codes. Development of transportation projects, particularly projects involving large-scale ground disturbance during construction may expose people and structures to risks where located on expansive soils. Industry practice and State-provided guidance would minimize risk associated with geologic hazards. As described above for land use projects, the potential hazards of unstable soil or geologic units would be addressed through the implementation of geotechnical recommendations in the planning and design process. Preventative measures, such as structural reinforcement for unstable geologic units and using engineered fill to replace unstable soils, would be required for the design of individual future projects. All site designs would be reviewed and approved by the appropriate federal, State, and local agencies.

The potential for expansive soils to result in adverse impacts to the transportation projects at the regional, local, and TPA level would be less than significant (LTS).

Conclusion

The proposed changes related to land use development pattern, sea level rise infrastructure, and transportation projects would be located on a range of different geologic materials and conditions. Hazards associated with unstable soils or geologic units are dependent on site- specific conditions, as well as the specific nature of the individual project proposed. With adherence to grading permit and building code requirements, including seismic design criteria as required by the CBC, and local building code requirements, the land use development pattern, sea level rise adaptation infrastructure, and transportation projects that may result from implementation of the proposed Plan would be designed to minimize potential risks related to expansive soils. Existing regulatory requirements specify mandatory and prescriptive actions that must occur during project development and would effectively reduce the inherent hazard. Therefore, this impact is **less than significant (LTS).**

Mitigation Measures

None required.

Impact GEO-7: Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature (PS)

Land Use, Sea Level Rise Adaptation, and Transportation System Impacts

Paleontological and geological resources are by nature specific to their local context, and as such, impacts on these resources resulting from the proposed Plan would occur at the local level. Therefore, regional effects are not addressed. In general, potential impacts on paleontological or geologic resources would be similar to those identified for archaeological resources discussed Impact CUL/TCR-2. Projects involving excavation, grading, or soil removal in previously undisturbed areas have the greatest likelihood to encounter these resources.

Table 3.8-4 shows a breakdown of these paleontological resources by epoch and county. There are 5,809 sites at which fossil remains have been found in the nine-county area, with the greatest concentration of 2,570 occurring in Contra Costa County and the second highest of 924 in San Mateo County. Napa County had the fewest paleontological sites at 143. Most paleontological resources were from the Miocene epoch (1,535), while the fewest were found from the Jurassic period (48).

The degree and extent of impacts would depend upon project location, and as such, project-specific analysis would be required to determine the precise area of impact and the importance of any paleontological or geologic resource identified within a proposed alignment or project area. This would be a potentially significant (PS) impact.

<u>**Conclusion**</u>

Because individual land use development pattern, sea level rise adaptation infrastructure, and transportation projects have the potential to adversely affect paleontological and geologic resources on a regional and localized level, these impacts would be **potentially significant (PS)**. Mitigation Measure GEO-7 addresses this impact and is described below.

Mitigation Measures

Mitigation Measure GEO-7 Implementing agencies and/or project sponsors shall implement measures, where feasible and necessary based on project- and site-specific considerations, that include those identified below:

- Ensure compliance with the Paleontological Resources Preservation Act, the Federal Land Policy and Management Act, the Antiquities Act, Section 5097.5 of the PRC, adopted county and city general plans, and other federal, State, and local regulations, as applicable and feasible, by adhering to and incorporating the performance standards and practices for the assessment and mitigation of adverse impacts on paleontological resources.
- Obtain review by a qualified paleontologist to determine whether the project has the potential to require ground disturbance of parent material with potential to contain unique paleontological resources or to require the substantial alteration of a unique geologic feature. The assessment should include museum records searches, a review of geologic mapping and the scientific literature, geotechnical studies (if available), and potentially a pedestrian survey if units with paleontological potential are present at the surface.
- Avoid exposure or displacement of parent material with potential to yield unique paleontological resources.
- Implement the following measures where avoidance of parent material with the potential to yield unique paleontological resources is not feasible:
  - All on-site construction personnel shall receive Worker Education and Awareness Program training before the commencement of excavation work to understand the regulatory framework that provides for protection of paleontological resources and become familiar with diagnostic characteristics of the materials with the potential to be encountered.
  - A qualified paleontologist shall prepare a paleontological resource management plan (PRMP) to guide the salvage, documentation, and repository of unique paleontological resources encountered during construction. If unique paleontological resources are encountered during construction, qualified paleontologist shall oversee the implementation of the PRMP.
  - Ground-disturbing activities in parent material with a moderate to high potential to yield unique paleontological resources shall be monitored using a qualified paleontological monitor to determine whether unique paleontological resources are encountered during such activities, consistent with the specified or comparable protocols.
- Identify where ground disturbance is proposed in a geologic unit having the potential to contain fossils, and specify the need for a paleontological monitor to be present during ground disturbance in these areas.
- Avoid routes and project designs that would permanently alter unique geological features.

- Salvage and document adversely affected resources sufficient to support ongoing scientific research and education.

- If paleontological resources are discovered during earthmoving activities, the construction crew will be directed to immediately cease work and notify the implementing agencies and/or project sponsors. The project sponsor will retain a qualified paleontologist for identification and salvage of fossils so that construction delays can be minimized. The paleontologist will be responsible for implementing a recovery plan which could include the following:

  - in the event of discovery, salvage of unearthed fossil remains, typically involving simple excavation of the exposed specimen but possibly also plaster-jacketing of large and/or fragile specimens, or more elaborate quarry excavations of richly fossiliferous deposits;

  - recovery of stratigraphic and geologic data to provide a context for the recovered fossil remains, typically including description of lithologies of fossil-bearing strata, measurement and description of the overall stratigraphic section, and photographic documentation of the geologic setting;

  - laboratory preparation (cleaning and repair) of collected fossil remains to a point of curation, generally involving removal of enclosing rock material, stabilization of fragile specimens (using glues and other hardeners), and repair of broken specimens;

  - cataloging and identification of prepared fossil remains, typically involving scientific identification of specimens, inventory of specimens, assignment of catalog numbers, and entry of data into an inventory database;

  - transferal, for storage, of cataloged fossil remains to an appropriate repository, with consent of property owner;

  - preparation of a final report summarizing the field and laboratory methods used, the stratigraphic units inspected, the types of fossils recovered, and the significance of the curated collection; and

  - project sponsors shall comply with existing local regulations and policies that exceed or reasonably replace any of the above measures that protect paleontological or geologic resources.

- Prepare significant recovered fossils to the point of curation, identified by qualified experts, listed in a database to facilitate analysis, and deposited in a designated paleontological curation facility.

  - Following the conclusion of the paleontological monitoring, ensure that the qualified paleontologist prepares a report stating that the paleontological monitoring requirement has been fulfilled and summarizes the results of any paleontological finds. The report should be submitted to the CEQA lead agency and to the repository curating the collected artifacts and should document the methods and results of all work completed under the PRMP, including the treatment of paleontological materials; results of specimen processing, analysis, and research; and final curation arrangements.

Significance after Mitigation

Implementation of Mitigation Measure GEO-7 would reduce impacts associated with paleontological resources because construction workers would be alerted to the possibility of encountering paleontological resources, and professionally accepted and legally compliant procedures for the discovery of paleontological resources would be implemented in the event of a find. To the extent that a local agency requires an individual project to implement all feasible mitigation measures described above, the impact would be less than significant with mitigation (LTS-M).

Projects taking advantage of the CEQA streamlining provisions of SB 375 (PRC Sections 21155.1, 21155.2, and 21159.28) must apply the mitigation measures described above, as applicable, to address site-specific conditions. However, MTC/ABAG cannot require local implementing agencies to adopt the above mitigation measures, and it is ultimately the responsibility of a lead agency to determine and adopt mitigation. Therefore, this impact would be **significant and unavoidable (SU)** for purposes of this program-level review.

Impact MR-1: Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state or a locally-important mineral resources recovery site delineated on a local land use plan (LTS)

Land Use, Sea Level Rise Adaptation, and Transportation System Impacts

Local jurisdictions have general plan policies to manage mineral resources and are required under SMARA to consider significant mineral deposits identified by CGS. The proposed Plan relies on local general plan development regulations to identify appropriate areas to protect and/or allow harvesting/mining of mineral resources. By developing more compactly, the proposed Plan directs more growth to the areas that are already developed and away from undeveloped land. Harvesting/mining of mineral resources in or near urban development may create incompatibilities, and/or may be economically infeasible. Compact growth and urban infill allow for the preservation of non-urban areas where mineral recourses may be more feasible to remove.

Local general plans, specific plans, and other land use plans include policies to protect existing and planned future mineral production and extraction activities from surrounding uses and require that future projects near mining activities have compatible land uses. In addition, the potential loss of availability of a designated mineral resource is a consideration in the final design of individual land use projects.

The land use development pattern, sea level rise adaptation infrastructure, and transportation projects that may result from implementation of the proposed Plan have been developed to most efficiently meet the demands created by the forecasted growth in population and jobs and focus mainly on development within designated growth geographies and the existing regional transportation system. Proposed transportation improvements would largely be constructed within existing ROWs. Sea level rise adaptation infrastructure located along the San Francisco Bay shoreline is mostly adjacent to developed areas or transportation infrastructure. In addition, the potential loss of availability of a designated mineral resource is a consideration in the final design of individual land use, sea level rise, or transportation projects and are addressed through local general plan policies consistent with SMARA requirements. Therefore, the proposed Plan would have a less-than-significant (LTS) impact.

Conclusion

Although implementing the proposed Plan's land use development pattern, sea level rise adaptation infrastructure, and transportation projects could result in development that would preclude the future extraction of mineral resources, these impacts would be less than significant because the projected land use growth was designed to be consistent with local planning documents, which are required to consider mineral resource zones mapped by the State in the land use decisions. Further, most development would be located in urban areas or within existing right of way for transportation-related uses where extraction of mineral resources is unlikely. This would be a **less-than-significant (LTS)** impact.

Mitigation Measures

None required.