4.6 GEOLOGY AND SOILS

This chapter describes the regulatory framework and existing conditions of the City of San Mateo Environmental Impact Report (EIR) Study Area and evaluates the potential geology and soils impacts from adopting and implementing the proposed General Plan 2040 and proposed Climate Action Plan update, and from future development and activities that could occur under the proposed project. A summary of the relevant regulatory framework and existing conditions is followed by a discussion of potential impacts and cumulative impacts related to implementation of the proposed project.

4.6.1 ENVIRONMENTAL SETTING

4.6.1.1 REGULATORY FRAMEWORK

Federal Regulations

The federal Paleontological Resources Preservation Act of 2002 limits the collection of vertebrate fossils and other rare and scientifically significant fossils to qualified researchers who have obtained a permit from the appropriate state or federal agency. Additionally, it specifies these researchers must agree to donate any materials recovered to recognized public institutions, where they will remain accessible to the public and to other researchers. This act incorporates key findings of a report, *Fossils on Federal Land and Indian Lands*, issued by the Secretary of the Interior in 2000, that establishes that most vertebrate fossils and some invertebrate and plant fossils are considered rare resources.[1]

State Regulations

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface fault rupture to structures used for human occupancy.[2] The main purpose of the act is to prevent the construction of buildings used for human occupancy on top of active faults. This act only addresses the hazard of surface fault rupture—not other earthquake hazards such as earthquake-induced liquefaction or landslides. The act requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones or Alquist-Priolo Zones) around surface traces of active faults and to issue appropriate maps. The maps, which are developed using existing United States Geological Survey's (USGS) 7.5-minute quadrangle map bases, are then distributed to all affected cities, counties, and State agencies for their use in planning and controlling new or renewed construction. Generally, construction within 50 feet of an active fault zone is prohibited.

[1] U.S. Department of the Interior, May 2000, *Fossils on Federal & Indian Lands, Report of the Secretary of the Interior*, https://www.blm.gov/sites/blm.gov/files/programs_paleontology_quick%20links_Assessment%20of%20Fossil%20Management%20on%20Federal%20%26%20Indian%20Lands%2C%20May%202000.pdf, accessed September 30, 2022.

[2] California Department of Conservation, 2019, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed September 30, 2022.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, which was passed in 1990, addresses seismic hazards such as liquefaction and seismically induced landslides.[3] Under this act, seismic hazard zones are mapped by the State Geologist to assist local governments in land use planning. Section 2691(c) of this act states that "it is necessary to identify and map seismic hazard zones in order for cities and counties to adequately prepare the safety element of their general plans and to encourage land use management policies and regulations to reduce and mitigate those hazards to protect public health and safety." Section 2697(a) of the act states that "cities and counties shall require, prior to the approval of a project located in a seismic hazard zone, a geotechnical report defining and delineating any seismic hazard."

California Building Code

The State of California provides a minimum standard for building design through Title 24, Part 2, of the California Code of Regulations (CCR), commonly referred to as the "California Building Code" (CBC). The CBC is updated every three years. It is generally adopted on a jurisdiction-by-jurisdiction basis, subject to further modification based on local conditions. The City of San Mateo regularly adopts each new CBC update under the San Mateo Municipal Code (SMMC) Chapter 23.08, *Building Code*. These codes provide minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other building elements to mitigate the effects of seismic shaking and adverse soil conditions. They also regulate grading activities, including drainage and erosion control.

California Environmental Quality Act

Paleontological resources are afforded protection under the California Environmental Quality Act (CEQA). The Society of Vertebrate Paleontology has set significance criteria for paleontological resources.[4] Most practicing professional vertebrate paleontologists adhere closely to the Society of Vertebrate Paleontology's assessment, mitigation, and monitoring requirements as specifically provided in its standard guidelines. Most State regulatory agencies with paleontological laws, ordinances, regulations, and standards accept and use the professional standards set forth by the Society of Vertebrate Paleontology.

California Public Resources Code Section 5097

California Public Resources Code (PRC) Section 5097.5 prohibits the destruction or removal of any paleontological site or feature from public lands without the permission of the jurisdictional agency.

[3] California Department of Conservation, 2019, Seismic Hazards Mapping Act, https://www.conservation.ca.gov/cgs/hazards/seismic-hazards-mapping-act, accessed September 30, 2022.

[4] Society of Vertebrate Paleontology, 2010, *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources*, https://vertpaleo.org/wp-content/uploads/2021/01/SVP_Impact_Mitigation_Guidelines.pdf, accessed September 30, 2022.

California Penal Code Section 622.5

The California Penal Code Section 622.5 details the penalties for damage or removal of paleontological resources, whether from private or public lands.

Regional Regulations

The purpose of hazard mitigation planning is to reduce the loss of life and property by minimizing the impact of disasters. The *San Mateo County Multi-Jurisdictional Hazard Mitigation Plan* (MJHMP), updated in 2021 in accordance with the federal Disaster Mitigation Action of 2000 (DMA 2000), provides an assessment of natural hazards in the county and a set of short-term mitigation actions to reduce or eliminate the long-term risk to people and property from these hazards. The San Mateo Jurisdictional Annex of the MJHMP provides an assessment of hazards and vulnerabilities, and a set of mitigation actions for San Mateo specifically while considering the results from the countywide effort. In the context of an MJHMP, mitigation is an action that reduces or eliminates long-term risk to people and property from hazards, including seismic hazards and erosion. Mitigation actions related to seismic hazards in the San Mateo Jurisdictional Annex of the MJHMP include adopting the most recent California Building Standards Code, retrofitting or relocating existing structures in high hazard areas, and adopting best practices for evacuation planning.

The MJHMP must be reviewed and approved by the Federal Emergency Management Agency (FEMA) every five years to maintain eligibility for disaster relief funding. As part of this process, the California Governor's Office of Emergency Services reviews all local hazard mitigation plans in accordance with DMA 2000 regulations and coordinates with local jurisdictions to ensure compliance with FEMA's Local Mitigation Plan Review Guide. As part of the proposed project, the MJHMP is adopted in its entirety into the proposed Safety Element by reference.

Local Regulations

San Mateo General Plan 2030

The City of San Mateo General Plan 2030 goals, policies, and actions that are relevant to geology and soils are primarily in the Safety Element. As part of the proposed project, some existing General Plan goals, policies, and actions would be amended, substantially changed, or new policies would be added. Applicable goals, policies, and actions are identified and assessed for their effectiveness and potential to result in an adverse physical impact later in this chapter under Section 4.6.3, *Impact Discussion*.

City of San Mateo Municipal Code

The SMMC includes various directives pertaining to geology and soils. The SMMC is organized by title, chapter, and section, and in some cases, articles. Most provisions related to geology and soil impacts are included in Title 7, *Health, Sanitation, and Public Nuisances*, Title 23, *Building and Construction*, and Title 26, *Subdivisions*.

- Chapter 7.38, *Sanitary Sewer Use*, requires that all new construction connects to the City's sanitary sewer system and includes requirements to prevent unauthorized releases into the system.

- Chapter 23.08, *Building Code*, adopts the 2022 CBC as the rules, regulations, and standards within the City as to all matters except as modified or amended in the SMMC. The CBC includes requirements for geotechnical reports at the discretion of the building official.
- Chapter 23.40, *Site Development Code*, is adopted to specifically to protect public and private lands from erosion, earth movement, and flooding, and establishes minimum standards and requirements relating to land grading, excavations and fills, and removal of major vegetation, including the preparation of geotechnical reports. The Site Development Code also regulates development on or near steep slopes in order to minimize the risk of personal injury, damage to property, and impact on water quality from potential landslides, erosion, earth creep, stormwater runoff, and other hazards associated with hillside areas of the City, as well as preserves existing topographical forms, open spaces, habitat areas and visual resources from encroachment by new hillside development. Site development planning applications may require an erosion and sediment control plan and control measures.
- Chapter 26.04, *General Provisions*, establishes the San Mateo City Subdivision Code to protect the community to the maximum extent from excessive stormwater runoff, wanton destruction of trees, increased soil erosion, earth movement, earthquake hazards, and other geological hazards. Applicants who are proposing subdivisions within the EIR Study Area must submit geotechnical reports before getting City approval on the final map. Problems of drainage are to be resolved in such manner as to provide substantial security against excessive runoff or flooding, earth movements and excessive erosion.

4.6.1.2 EXISTING CONDITIONS

Geology

The EIR Study Area is in the USGS's San Mateo Quadrangle 7.5-minute topographic map area.[5] The area is typified by northwest-southwest-trending mountain ridges and intervening valleys.[6] Elevations range from sea level to approximately 676 feet at Black Mountain. Regional mapping completed by the USGS indicates that there are 16 geologic units in the EIR Study Area.[7] These units are broadly categorized by the USGS into four main units as Unconsolidated, undifferentiated, Sedimentary, clastic, Metamorphic, serpentinite, and Melange. Figure 4.6-1, *Geology Map*, shows the location of each geologic category in the EIR Study Area.

- **Unconsolidated, undifferentiated:** This unit includes alluvium, colluvium and artificial fill. Alluvium consists of sediment that has been transported and deposited by streams. Alluvium is vulnerable to seismically induced instability. Colluvium contains deposits of unconsolidated solid material and weathered rock fragments that gather at the base of slopes by gravitational or slope wash processes. Colluvium may be susceptible to flow failures.

[5] United States Geological Survey, 1980, San Mateo Quadrangle California 7.5-Minute Topographic Map, scale 1:24,000.
[6] Tetra Tech, 2021, Multijurisdictional Local Hazard Mitigation Plan, Volume 1, Planning-Area-Wide Elements.
[7] Pampeyan, E. H., 1981, Geologic Map, Geology and Former Shoreline Features of the San Mateo 7.5-Minute Quadrangle, San Mateo County, California, United States Geological Survey Open-File Report 81-839, scale 1:24,000.

- **Sedimentary, clastic:** This unit includes greywacke sandstone with interbedded siltstone, shale, pebble conglomerate along with other units within the Franciscan Assemblage. This unit is primarily found within the lower portion of the foothills of the EIR Study Area.
- **Melange:** The bedrock in the EIR Study Area consists of sheared rock (mélange), which is a weak matrix of sheared and altered shale and sandstone that contains serpentine, greenstone, chert, limestone, and schist. Sheared rock (mélange) is susceptible to landslides, whereas Franciscan sandstone and shale are more stable. This geologic unit is found primarily in the hillsides of the EIR Study Area.
- **Serpentinite:** Serpentinite is a metamorphic rock which forms at tectonic plate boundaries. Serpentinite is often formed in Franciscan Complexes when ocean water is heated and moved through upper mantle and ocean crust rocks, which hydrates the magnesium and iron-rich materials in the rocks.

Unique geologic features are those that are unique to the field of geology. Each rock unit tells a story of the natural processes operating at the time it was formed. The rocks and geologic formations exposed at the earth's surface or revealed by drilling and excavation are our only record of that geologic history. What makes a geologic unit or feature unique can vary considerably. For example, a geologic feature may be considered unique if it is the best example of its kind and has distinctive characteristics of a geologic principle that is exclusive locally or regionally, is a key piece of geologic information important to geologic history, contains a mineral that is not known to occur elsewhere in the area, or is used as a teaching tool. Unique geological features are not common in San Mateo or the EIR Study Area. The geologic processes are generally the same as those in other parts of the state, country, and even the world. The geology and soils in the EIR Study Area are common throughout the city and region and are not considered to be unique.

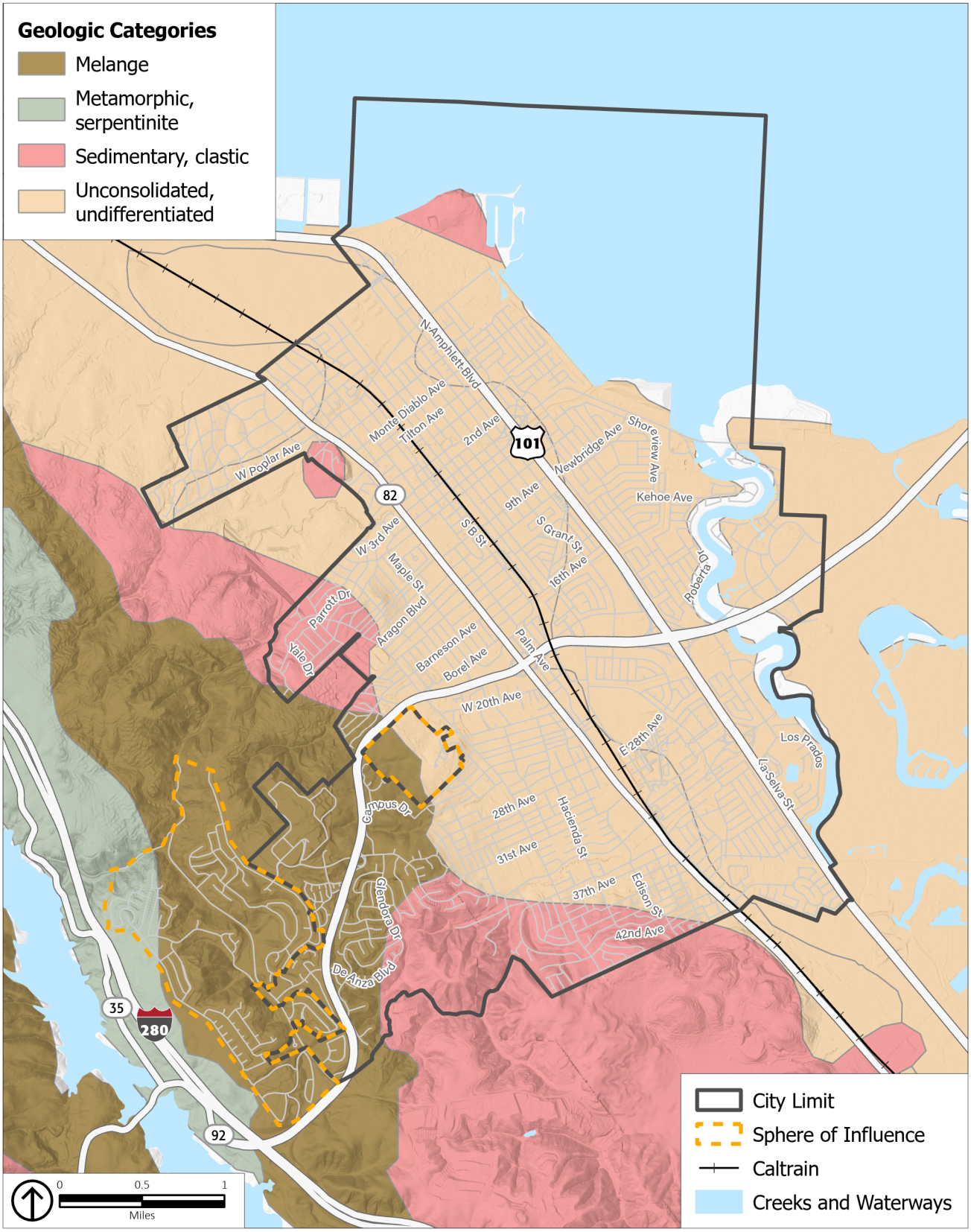
Soils

The soils in the EIR Study Area have been mapped by the United States Department of Agriculture (USDA) Natural Resource Conservation Services. In general, the soils beneath the EIR Study Area are dominated by well-drained, shallow to moderately deep, fine-loamy soils such as loam and clay loam in the uplands, with additional areas of poorly drained clay and silty soils in the tidal flats and salt marshes.[8] According to the USDA, the most prevalent soil types are the Fagan loam, Los Gatos loam, Maymen gravelly loam, Novato clay, Obispo clay, urban land, and Typic Argiustolls, as shown on Figure 4.6-2, *Soils Map*.

The properties of these soils are variable, ranging from fine-loamy soils of the Fagan series, Los Gatos series and Maymen series, to completely urbanized in the urban land classification. According to published soil data, several soil types, notably the Maymen-Los Gatos, are characterized by steep slopes and erosion hazards, where landslides and flows are possible.[9]

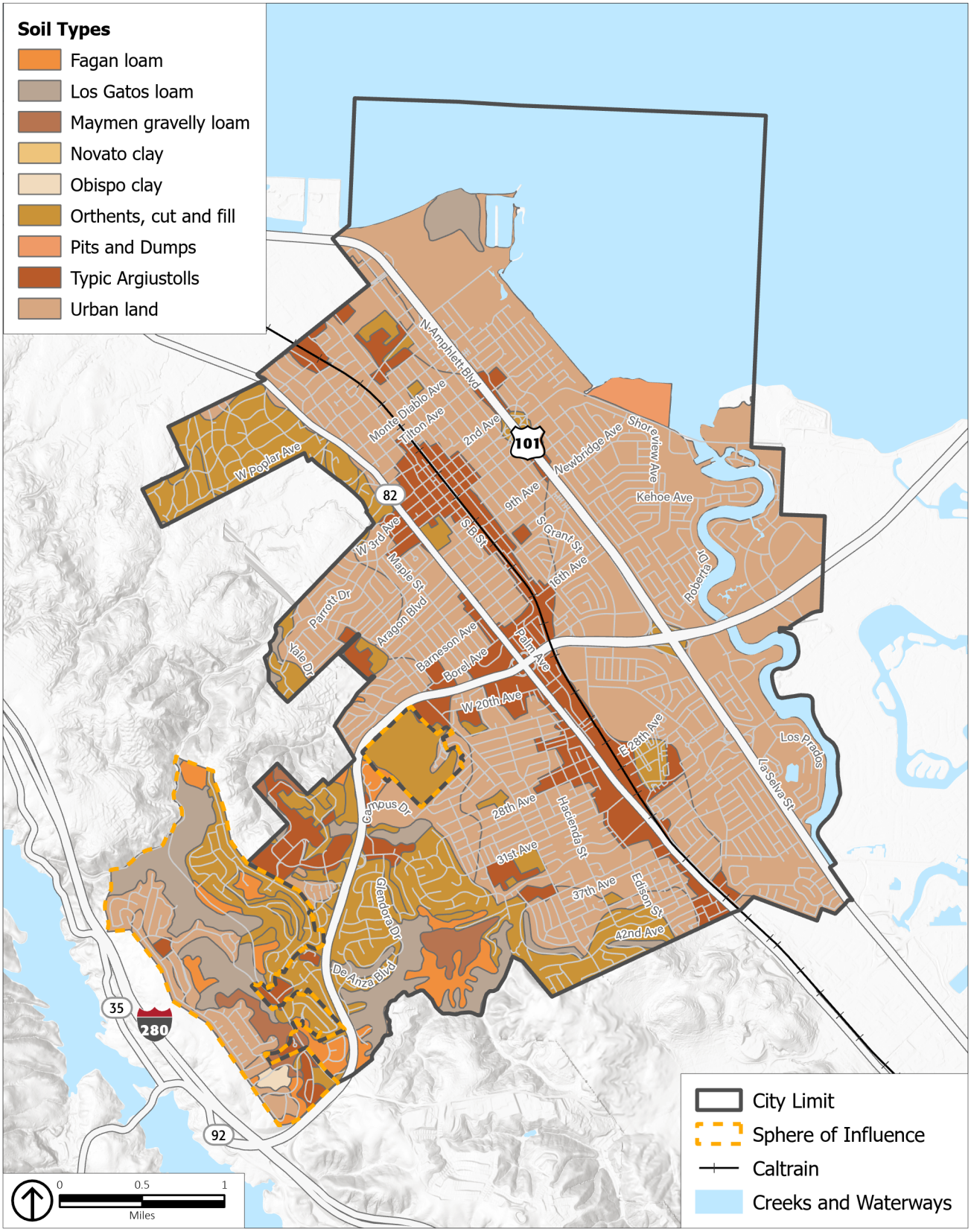
[8] USDA Soil Conservation Service, 1991, Soil Survey of San Mateo County, eastern part, and San Francisco County, California.

[9] USDA Soil Conservation Service, 1991, Soil Survey of San Mateo County, eastern part, and San Francisco County, California.



Source: USGS, 2023; PlaceWorks, 2023.

Figure 4.6-1
Geology Map



Source: USDA, 2023; PlaceWorks, 2023.

Figure 4.6-2
Soils Map

Regional Seismicity

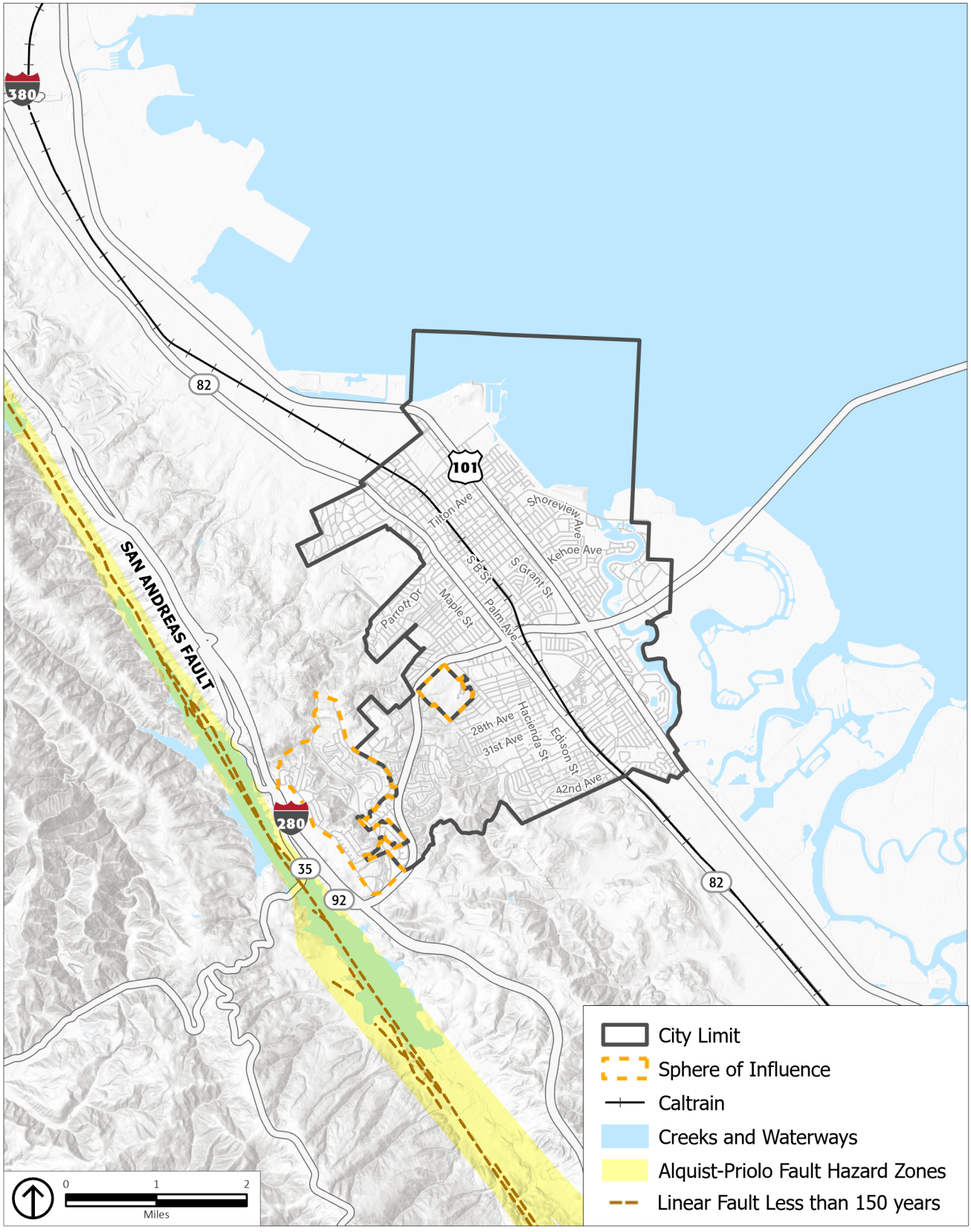
The Earth's crust includes tectonic plates that collide or slide past one another along plate boundaries. California is particularly susceptible to such plate movements, notably the largely horizontal or "strike-slip" movement of the Pacific Plate as it impinges on the North American Plate. In general, earthquakes occur when the accumulated stress along a plate boundary or fault is suddenly released. This slippage can vary widely in magnitude, from a few millimeters or centimeters to tens of feet.

The performance of human-made structures during a major seismic event varies widely due to a number of factors, including location with respect to active fault traces or areas prone to liquefaction or seismically induced landslides; the type of building construction (e.g., wood frame, unreinforced masonry, nonductile concrete frame); and the proximity, magnitude, depth, and intensity of the seismic event itself. In general, evidence from past earthquakes shows that wood-frame structures tend to perform well, especially when their foundations are properly designed and anchored. Conversely, older, unreinforced masonry structures and nonductile reinforced concrete buildings (especially those built in the 1960s and early 1970s) do not perform well, especially if they have not undergone appropriate seismic retrofitting. Applicable building code regulations, such as those in the CBC, include seismic requirements that are designed to ensure the satisfactory performance of building materials under prescribed seismic conditions.

The EIR Study Area, like much of the San Francisco Bay Area, is vulnerable to seismic activity due to the presence of active faults in the region. The most prominent active fault near the EIR Study Area is the San Andreas Fault approximately about a half mile to the southwest at its nearest point, as shown on Figure 4.6-3, *Faults Map*. There are no known active faults in the EIR Study Area, so surface fault rupture is not considered a significant hazard.

The severity of ground shaking depends on several variables, such as earthquake magnitude and origin; local geology, including the properties of unconsolidated sediments; groundwater conditions; and topographic setting. In general, ground shaking hazards are most pronounced in areas that are underlain by loosely consolidated soil/sediment.[10]

[10] Southern California Earthquake Center, 2011, *Putting Down Roots in Earthquake Country*, Lucile M. Jones, United States Geological Survey, and Mark Benthien, SCEC.



Source: USGS, 2019; DOC, 2023; PlaceWorks, 2023.

Figure 4.6-3
Faults Map

When earthquake faults within the San Francisco Bay Area's nine-county area were considered, the USGS estimated that the probability of a magnitude (M) 6.7 or greater earthquake prior to year 2044 is 72 percent, or nearly a three-quarters probability. The forecast probability for each individual fault to produce an M 6.7 or greater seismic event by the year 2044 is 32 percent for the Hayward Fault, 33 percent for the San Andreas Fault, and 25 percent for the Calaveras Fault.[11] Earthquakes of this magnitude can create ground accelerations severe enough to cause major damage to structures and foundations not designed to resist earthquakes. Underground utility lines are also susceptible where they lack sufficient flexibility to accommodate the seismic ground motion.[12] In the event of an M 7.8 earthquake on the San Andreas Fault, the seismic forecasts on the Association of Bay Area Governments' interactive GIS website (developed by a cooperative working group that included the USGS and the CGS) suggest that most parts of the EIR Study Area are expected to experience "violent" shaking.[13] The April 1906 earthquake on the San Andreas Fault, estimated between M 7.7 and M 8.3, was the largest seismic event in recent history that affected the EIR Study Area. More recently, the M 6.9 Loma Prieta earthquake of October 1989 on the San Andreas Fault caused significant damage throughout the San Francisco Bay Area, although no deaths were reported in San Mateo County.

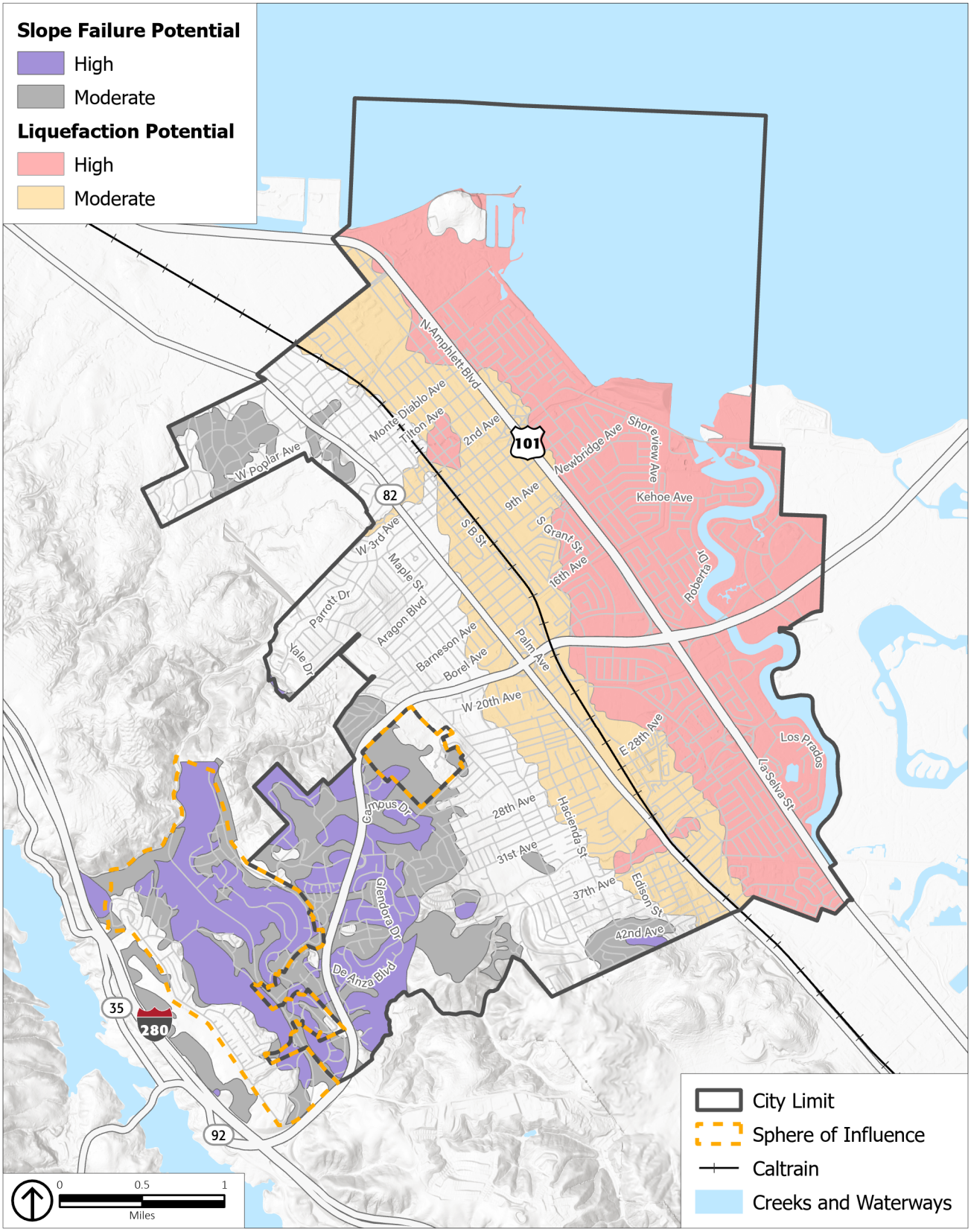
Liquefaction

Liquefaction typically occurs in areas where moist, fine-grained, cohesionless sediment or fill materials are subjected to strong, seismically induced ground shaking. Under certain circumstances, the ground shaking can temporarily transform an otherwise solid material to a fluid state, which can result in the horizontal movement of soils on gentle slopes, called lateral spreading. Liquefaction is a serious hazard and may result in buildings that subside and suffer major structural damage. Liquefaction is most often triggered by seismic shaking, but it can also be caused by improper grading, landslides, or other factors. In dry soils, seismic shaking may cause soil to consolidate rather than flow, a process known as densification. Liquefaction in the EIR Study Area ranges from very low in the hillsides of the city to very high in the marshland and tidal marshes on the eastern side of the EIR Study Area, as shown on Figure 4.6-4, *Seismic Hazard Zones*.

[11] United States Geological Survey, 2015, Uniform California Earthquake Rupture Forecast 3: A New Earthquake Forecast for California's Complex Fault System, Fact Sheet 2015-3009.

[12] Association of Bay Area Governments, 1995, *The San Francisco Bay Area On Shaky Ground*, Publication Number P95001EQK, 13 maps, scale 1:1,000,000.

[13] Association of Bay Area Governments, 2023, MTC/ABAG Hazard Viewer Map, Earthquake Shaking Scenarios, https://mtc.maps.arcgis.com/apps/webappviewer/index.html?id=4a6f3f1259df42eab29b35dfcd086fc8, accessed May 26, 2023.



Source: City of San Mateo, 2022; PlaceWorks, 2023.

Figure 4.6-4
Seismic Hazard Zones

The northeastern portion of the EIR Study Area located along the San Francisco Bay is predominantly unconsolidated soils, which consist of soft, unconsolidated, water-saturated, silty clay with shell fragments.[14] These low-lying areas that front the Bay are particularly susceptible to liquefaction.[15] In the western portions of the EIR Study Area, the soils consist of colluvium and bedrock, which have a low susceptibility to liquefaction. As shown on Figure 4.6-4, the majority of the liquefaction susceptibility areas in the EIR Study Area are in urbanized, low-lying areas near creeks or the waterfront. Many of the open space areas and hillside neighborhoods are in low or very low liquefaction susceptibility areas.

Landslides

Landslides are gravity-driven movements of earth materials that can include rock, soil, unconsolidated sediment, or combinations of such materials. The rate of landslide movement can vary considerably; some move rapidly, as in a soil or rock avalanche, and others "creep," or move slowly for long periods of time. The susceptibility of a given area to landslides depends on many variables, although the general characteristics that influence landslide hazards are widely acknowledged. Some of the more important contributing factors are:

- **Slope Material.** Loose, unconsolidated soils and soft, weak rocks are more hazardous than firm, consolidated soils or hard bedrock.
- **Slope Steepness.** Most landslides occur on moderate to steep slopes.
- **Structure and Physical Properties of Materials.** This includes the orientation of layering and zones of weakness relative to slope direction.
- **Water Content.** Increased water content increases landslide hazard by decreasing friction and adding weight to the materials on a slope.
- **Vegetation Coverage.** Abundant vegetation with deep roots promotes slope stability.
- **Proximity to Areas of Erosion or Man-Made Cuts.** Undercutting slopes can greatly increase landslide potential.
- **Earthquake Ground Motions.** Strong seismic ground motion can trigger landslides in marginally stable slopes or loosen slope materials, which increases the risk of future landslides.

As shown in Figure 4.6-4, landslides have the potential to occur in the EIR Study Area, most notably on the steeper slopes that lie on the western edge of the EIR Study Area. In these areas, landslides are commonly associated with slopes underlain with Franciscan sheared rock (mélange) and pre-existing landslide deposits, which indicate unstable underlying materials.[16]

[14] Pampeyan, E. H., 1981, Geologic Map, Geology and Former Shoreline Features of the San Mateo 7.5-Minute Quadrangle, San Mateo County, California, United States Geological Survey Open-File Report 81-839, scale 1:24,000.

[15] Association of Bay Area Governments, 2023, MTC/ABAG Hazard Viewer Map, Earthquake Liquefaction Susceptibility, https://mtc.maps.arcgis.com/apps/webappviewer/index.html?id=4a6f3f1259df42eab29b35dfcd086fc8, accessed May 26, 2023.

[16] Association of Bay Area Governments, 2023, MTC/ABAG Hazard Viewer Map, Landslide Hazard (Rainfall Induced), https://mtc.maps.arcgis.com/apps/webappviewer/index.html?id=4a6f3f1259df42eab29b35dfcd086fc8, accessed May 26, 2023.

Sheared rock (mélange) is the most unstable of the many rock types within the Franciscan Formation, whereas sandstone and conglomerate units tend to be more stable with a lower landslide risk. Many of the upland areas in the EIR Study Area are characterized by steep slopes and soils that overlie Franciscan bedrock. Landslides are not an issue in parts of the EIR Study Area where the topography is flat. Due to the differences in the physical characteristics of slope materials, which markedly influence landslide potential, some superficially similar areas may differ widely in terms of landslide hazards. For this reason, site-specific geotechnical investigations are essential to the accurate assessment of potential landslide hazards at any given site.

Erosion

Erosion occurs when the upper layers of soil are displaced by erosive agents such as water, ice, snow, air, plants, animals, or anthropogenic forces. Sandy soils on moderate slopes or clayey soils on steep slopes are susceptible to erosion when exposed to these forces.[17] Erosion can become more frequent when established vegetation is disturbed or removed due to grading, wildfires, or other factors. Within the valley areas of the EIR Study Area, water flow in streams and rivers can erode the banks of waterways, causing the stream or river to meander. Erosion can cause the soil underneath buildings and structures to become compromised or fail, which is typically limited to localized areas.

Land Subsidence

Land subsidence refers to the lowering of the ground surface due to extraction or lowering of water levels or other stored fluids within the subsurface soil pores, or due to seismic activity that can cause alluvial sediments to compact.

Known current and historical instances of land subsidence in California have been recorded by the USGS. The EIR Study Area is not included in the USGS' areas of known land subsidence.[18] In addition, the project site is not in an area served by water districts that rely on local groundwater for their municipal supply.[19] Based on the lack of large-scale groundwater extraction within the EIR Study Area, land subsidence is unlikely to be a significant hazard.[20]

Expansive Soils

Expansive soils can change dramatically in volume depending on moisture content. When wet, these soils can expand; when dry, they can contract or shrink. Sources of moisture that can trigger this shrink-swell phenomena can include seasonal rainfall, landscape irrigation, utility leakage, and/or perched

[17]USDA Soil Conservation Service, 1991, Soil Survey of San Mateo County, eastern part, and San Francisco County, California.

[18] United States Geological Survey, 2023, Areas of Land Subsidence in California, https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html, accessed May 26, 2023.

[19] California Water Service, 2021, *2020 Urban Water Management Plan: Mid-Peninsula District*. https://www.calwater.com/docs/uwmp2020/MPS_2020_UWMP_FINAL.pdf, accessed April 6, 2023.

[20] California Department of Water Resources, 2023, SGMA Data Viewer, https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer#gwlevels, accessed May 31, 2023.

groundwater. Expansive soil can exhibit wide cracks in the dry season, and changes in soil volume have the potential to damage concrete slabs, foundations, and pavement. Special building/structure design or soil treatment are often needed in areas with expansive soils.

Expansive soils are typically very fine grained with a high to very high percentage of clay, typically montmorillonite, smectite, or bentonite clay. Linear extensibility soil tests are often used to identify expansive soils, wherein soil sample volume/length changes in response to reduced moisture content.[21] A linear extensibility of 3 percent or greater connotes moderate to high shrink-swell potential. This soil behavior has the potential to cause damage to buildings, roads, and other structures.

Expansive soils are not common in the EIR Study Area; however, they can exist in localized areas such as the Bay Mud geologic units that underlie parts of eastern San Mateo.[2223] The USDA Web Soil Survey (a nationwide data repository) for the EIR Study Area demonstrates low ratings of linear extensibility and plasticity for the majority of the soils in the EIR Study Area, with moderate (i.e. Fagan loam) or high (i.e. Novato clay) ratings dispersed throughout the hillside areas of the EIR Study Area.[24] Expansive soils are typically identified during project review stages prior to construction, and require specific engineering methods to reduce stresses to buildings and infrastructure. A geotechnical investigation generally provides the most reliable means of evaluating and mitigating such soil characteristics.

Paleontological Resources

Paleontological resources (fossils) are the remains and/or traces of prehistoric plant and animal life exclusive of human remains or artifacts. Fossil remains such as bones, teeth, shells, and wood are found in the geologic deposits (rock formations) in which they were originally buried. Paleontological resources represent a limited, non-renewable, sensitive scientific and educational resource. The potential for fossil remains at a location can be predicted through previous correlations established between the fossil occurrence and the geologic formations where they were buried. For this reason, geologic knowledge of a particular area and the paleontological resource sensitivity of particular rock formations make it possible to predict where fossils will or will not be encountered.

A search of the University of California Museum of Paleontology Specimen Search database indicated there are 1,697 recorded paleontological specimens within the County of San Mateo, most of which were found in the Woodside Area or at beach locations such as Moss Beach and San Gregorio Beach.[25]

[21] Army Corps of Engineers Field Manual TM 5-818-7, 1985, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/tm5_818_7.pdf, accessed May 26, 2023.

[22] Pampeyan, E. H., 1981, Geologic Map, Geology and Former Shoreline Features of the San Mateo 7.5-Minute Quadrangle, San Mateo County, California, United States Geological Survey Open-File Report 81-839, scale 1:24,000.

[23] USDA, 2023, Web Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx, accessed May 26, 2023.

[24] USDA, 2023, Web Soil Survey, https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx, accessed May 26, 2023.

[25] University of California Museum of Paleontology, Specimen Search, https://ucmpdb.berkeley.edu/cgi/ucmp_query2, accessed May 26, 2023.

4.6.2 STANDARDS OF SIGNIFICANCE

The proposed project would result in a significant geology and soils impact if it would:

1. Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving: i) 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; ii) strong seismic ground shaking; iii) seismic-related ground failure, including liquefaction; iv) landslides.
2. Result in substantial soil erosion or the loss of topsoil.
3. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
4. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.
5. Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.
6. Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.
7. In combination with past, present, and reasonably foreseeable projects, result in cumulative geology and soils impacts in the area.

4.6.3 IMPACT DISCUSSION

GEO-1	**The proposed project would not directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury or death involving: i) 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; ii) Strong seismic ground shaking; iii) Seismic-related ground failure, including liquefaction; iv) Landslides.**

Earthquake Fault Rupture

As discussed in Section 4.6.1.2, *Existing Conditions*, there are no known active faults in the EIR Study Area, and the nearest fault is the San Andreas Fault, approximately a half mile to the west. The EIR Study Area is not in an Alquist-Priolo Fault Zone.[26]

[26] California Geological Survey, Alquist-Priolo Earthquake Fault Zoning Act, https://www.conservation.ca.gov/cgs/alquist-priolo, accessed on May 26, 2023.

The Safety (S) Element of the proposed General Plan contains goals, policies, and actions that require local planning and development decisions to consider seismic impacts. The following General Plan goal and policy serve to minimize potential adverse impacts from ground failure:

- **Goal S-1:** Minimize potential damage to life, environment, and property through timely, well-prepared, and well-coordinated emergency preparedness, response plans, and programs.
  - **Policy S 1.3: Location of Critical Facilities.** Avoid locating critical facilities, such as hospitals, schools, fire, police, emergency service facilities, and other utility infrastructure, in areas subject to slope failure, wildland fire, flooding, sea level rise, and other hazards, to the extent feasible.
  - **Policy S 1.6: Emergency Infrastructure and Equipment.** Maintain and fund the City's emergency operations center in a full functional state of readiness. Designate a back-up Emergency Operations Center with communications redundancies.
- **Goal S-2:** Take steps to protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.
  - **Policy S 2.1: Geologic Hazards.** Require site-specific geotechnical and engineering studies, subject to the review and approval of the delegated City Engineer and Building Official, for development proposed on sites identified in Figure S-4 [of the proposed General Plan] as having moderate or high potential for ground failure. Permit development in areas of potential geologic hazards only where it can be demonstrated that the project will not be endangered by, nor contribute to, the hazardous condition on the site or on adjacent properties.

Furthermore, SMMC Chapter 23.08, Chapter 23.40, and Chapter 26.04 require geotechnical investigations to protect the community from earth movement, earthquake hazards, and other geological hazards.

Based on the lack of known active faults in the EIR Study Area, compliance with SMMC regulations and proposed General Plan goals and policies identified above would ensure implementation of proposed project would not directly or indirectly cause the risk of loss, injury, or death involving rupture of a known earthquake fault. Therefore, the impact would be *less than significant.*

Seismic Ground Shaking

The intensity of ground shaking at a given location depends on several factors, primarily on the earthquake magnitude, the distance from the epicenter, and the characteristics of the soils or bedrock units underlying the site. The San Gregorio, Hayward and San Andreas Faults, which are closest to the EIR Study Area, are potentially capable of producing the most intense ground accelerations in the EIR Study Area due to their proximity. Secondary effects of earthquakes are nontectonic processes such as liquefaction, lateral spreading, seismically induced landslides, and ground lurching, which can lead to ground deformation. Ground deformation, including fissures, settlement, displacement, and loss of bearing strength, are the leading causes of damage to structures during a moderate to large earthquake.

The proposed Safety (S) Element contains goals, policies, and actions that require local planning and development decisions to consider impacts that contribute to the risk of loss, injury, or death as a result of earthquakes. In addition to proposed General Plan goals and policies listed above, the following

General Plan 2040 goal, policy, and actions would serve to minimize potential adverse impacts from seismic hazards:

- **Goal S-2:** Take steps to protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.
  - **Policy S 2.3: Vulnerable Buildings.** Encourage modifications to existing unreinforced masonry and soft story buildings, and similar unsafe building conditions to reduce the associated life safety hazards from ground shaking during earthquakes, as shown on Figure S-3 [of the proposed General Plan]. Require voluntary structural modifications to be designed in character with the existing architectural style.
  - **Action S 2.5: Seismic Shaking Mapping.** Consult with a geology specialist to update the City's geologic hazard mapping, documenting the areas within the city with moderate or high potential for liquefaction or ground failure, as shown in Figure S-4. [of the proposed General Plan].
  - **Action S 2.6: Incentive for Seismic Upgrades.** Develop and implement a program to provide financial incentives and education to building owners to support seismic upgrades.
  - **Action S 2.7: Seismic Stability.** Review the seismic stability of the City's assets and infrastructure, such as City Hall, recreational facilities, roadways, and bridges and identify improvements necessary to enhance each facility's ability to withstand geologic hazards, up to and including a full replacement of the facility.

In northern California, there is no method to completely avoid earthquake hazards. However, appropriate measures to minimize the effects of earthquakes are included in the CBC, with specific provisions for seismic design. The design of structures in accordance with the CBC would minimize the effects of ground shaking to the greatest degree feasible, except for during a catastrophic seismic event. Additionally, development projects under the proposed project would be required to comply with SMMC requirements for geotechnical reports on a project-by-project basis. Because future development under the proposed project would be required to comply with both the CBC and the SMMC, as well as proposed General Plan goals and policies discussed above, implementation of the proposed project would not cause or worsen seismic ground shaking; therefore, the impact would be *less than significant*.

Liquefaction

The EIR Study Area contains a range of geological and soil profiles. Within the EIR Study Area, liquefaction susceptibility ranges from low in steeply sloped areas to moderate and very high in the marshland and tidal marshes on the eastern side of the EIR Study Area, as shown on Figure 4.6-4. As discussed in Chapter 3, *Project Description*, of this Draft EIR, future development under the proposed project is expected to occur in existing urban areas and would be largely concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. These urban areas are generally located in portions of the EIR Study Area that have low liquefaction susceptibility. However, some existing urban areas in the EIR Study Area are built atop soil materials which have a high liquefaction susceptibility.

The proposed Safety (S) Element contains goals, policies, and actions that require local planning and development decisions to consider impacts that contribute to the risk of loss, injury, or death as a result of earthquakes. In addition to proposed General Plan goals, policies, and actions listed above, the following General Plan 2040 goal, policy, and actions would serve to minimize potential adverse impacts from liquefaction:

- **Goal S-2:** Take steps to protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.
    - **Policy S 2.4: Liquefaction.** Use the best-available liquefaction mapping data to avoid siting and locating new public facilities and infrastructure in areas susceptible to liquefaction, as shown in Figure S-4 [of the proposed General Plan].

In the event that future development is proposed on areas with potential liquefaction susceptibility, the development would be required to comply with existing regulations in the CBC and undergo a geotechnical review in accordance with SMMC regulations. Compliance with CBC, SMMC, and proposed General Plan goals, policies, and actions would minimize the risk of loss, injury, or death involving liquefaction after a seismic-related ground failure, and impacts would be *less than significant*.

Landslides

Portions of the EIR Study Area susceptible to landslides are on the steep slopes to the west and in hilly areas. As described above, future development under the proposed project is expected to be concentrated in existing urban areas.

The proposed Safety (S) Element contains goals, policies, and actions that require local planning and development decisions to consider impacts that contribute to the risk of loss, injury, or death as a result of earthquakes. In addition to proposed General Plan goals, policies, and actions listed above, the following General Plan 2040 goal and policy would serve to minimize potential adverse impacts from landslide:

- **Goal S-2:** Take steps to protect the community from unreasonable risk to life and property caused by seismic and geologic hazards.
    - **Policy S 2.2: Landslides and Erosion Control.** Reduce landslides and erosion in existing and new development through continuing education of design professionals on mitigation strategies. Control measures shall retain natural topographic and physical features of the site, if feasible.

Furthermore, new development or redevelopment in any of the portions of the EIR Study Area deemed to be within landslide-susceptible areas would be required to comply with grading, erosion, and sediment control regulations in the CBC and the provisions in the SMMC for geotechnical investigations. Compliance with CBC and SMMC, as well as the proposed General Plan goals, policies, and actions discussed above, would minimize the risk of loss, injury, or death involving landslide after a seismic-related ground failure and ensure that impacts would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-2 The proposed project would not result in substantial soil erosion or the loss of topsoil.

Substantial soil erosion or the loss of topsoil during construction of future development under the proposed project could undermine structures or minor slopes, which would be a concern during implementation of the proposed project.

As discussed in Chapter 3, *Project Description*, of this Draft EIR, future development under the proposed project is expected to occur in urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. The CBC provides regulations for construction to provide proper grading, drainage, and erosion and sediment control. In addition, SMMC Chapter 23.40 is adopted to specifically to protect public and private lands from erosion, earth movement, and flooding, and establishes minimum standards and requirements relating to land grading, excavations and fills, and removal of major vegetation. The Site Development Code also regulates development on or near steep slopes in order to minimize the risk of personal injury, damage to property, and impact on water quality from potential landslides, erosion, earth creep, stormwater runoff, and other hazards associated with hillside areas of the EIR Study Area, as well as preserves existing topographical forms, open spaces, habitat areas and visual resources from encroachment by new hillside development. Site development planning applications may require an erosion and sediment control plan and control measures. SMMC Chapter 26.04 establishes the San Mateo City Subdivision Code to protect the community to the maximum extent from excessive stormwater runoff, wanton destruction of trees, increased soil erosion, earth movement, earthquake hazards, and other geological hazards. Problems of drainage are to be resolved in such manner as to provide substantial security against excessive runoff or flooding, earth movements and excessive erosion.

Furthermore, because future development is anticipated to occur as infill or redevelopment in urban areas, development is not likely to result in substantial soil erosion or loss of topsoil. Adherence to existing regulatory requirements that include, but are not limited to, the CBC and the SMMC grading and drainage requirements for new developments, would ensure that impacts associated with substantial erosion and loss of topsoil from potential future development would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-3 The proposed project would not be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

Unstable geologic units are known to be present within the EIR Study Area. As discussed under impact discussion GEO-1, landslides have historically occurred and could continue to occur in areas with steeper slopes and less stable soil types. These include areas with steep slopes on the west and hilly areas of the EIR Study Area. Subsidence hazards are not known to be present in the EIR Study Area. Liquefaction

susceptibility ranges from low in upland and hillside areas, to high along the bayfront and beside streams.

As discussed in Chapter 3, *Project Description*, of this Draft EIR, future development under the proposed project would occur in existing urban areas and would be concentrated on a limited number of vacant parcels and in the form of infill/intensification on sites either already developed and/or underutilized, and/or in close proximity to existing residential and residential-serving development. The areas of high liquefaction susceptibility are not located in the highly urbanized portions within the EIR Study Area where potential future development is anticipated to occur; therefore, future development under the proposed project is not expected to be intentionally located on a geologic unit or on soil that is unstable. However, there is the potential that future development could occur near areas of potential landslides, lateral spreading, subsidence, liquefaction, or collapse.

As determined in impact discussions GEO-1 and GEO-2, future development under the proposed project would be required to comply with the CBC, which provides regulations for building design and construction to ensure geologic and soil stability. Additionally, the City requires that geotechnical reports be prepared and submitted to the City prior to approval or construction of applicable projects pursuant to the requirements set forth in SMMC Chapter 23.08, Chapter 23.40, and Chapter 26.04. In addition to protections afforded by State laws, proposed General Plan goals, policies, and actions listed under impact discussion GEO-1 would require local planning and development decisions to consider potential risks of development on unstable soils or geologic units. Proposed Goal S-2 and Policies S 2.1, S 2.2, and S 2.4, specifically address the location of future development and include development standards that prohibit development in areas where there is a potential danger from geologic hazards.

All future development under the proposed project would be required to comply with State and local regulations, including SMMC provisions and proposed General Plan goals, policies, and actions that minimize impacts related to unstable geologic units and soils where landslide, lateral spreading, subsidence, liquefaction, or collapse could occur in the EIR Study Area. Proposed General Plan goals, policies, and actions would also require ongoing review, identification, and maintenance of maps and regulations related to geologic and seismic hazards. Therefore, implementation of proposed project would not result in development on a geologic unit or on soils that are unstable and could result in landslides, lateral spreading, subsidence, liquefaction, or collapse, and impacts would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-4 The proposed project would not 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.

While expansive soils are not common in the EIR Study Area, they could potentially exist in localized areas such as the Novato clay units found in hillside areas or Bay Mud geologic units underlying the eastern portions of the EIR Study Area. These soils are typically identified during project review stages and require specific engineering methods to reduce stresses to buildings and infrastructure. Because

future development under the proposed project is anticipated to be concentrated in urbanized areas, it is not likely that development would occur in these portions of the EIR Study Area. However, in the event that future development is proposed in these portions of the EIR Study Area and is located on Novato clay or a Bay Mud geologic unit, a geotechnical investigation would be required to evaluate soil characteristics and identify mitigation if the soils are determined to be expansive. Such investigations are required by SMMC Chapter 23.08 which requires that future development proposed on expansive soils follow regulations imposed by the CBC, such as standards for seismic safety, excavation, foundations, retaining walls, site demolition, and grading activities including drainage and erosion control. Furthermore, requirements for geotechnical investigations at development site locations where potential hazards, including land instability, have already been identified are bolstered by various proposed General Plan goals, policies, and actions, as listed in impact discussion GEO-1.

Potential future development under the proposed project would be required to comply with existing regulations adopted to minimize development on expansive soils in the EIR Study Area as part of the City's project approval process. Potential future development would also comply with the proposed General Plan goals, policies, and actions that require ongoing review, identification, and maintenance of maps and regulations related to geologic and seismic hazards. Therefore, impacts would be *less-than-significant*.

Significance without Mitigation: Less than significant.

GEO-5 The proposed project would not have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.

SMMC Chapter 7.38 requires all new construction to connect to the City's sanitary sewer system. Wastewater from new lots or parcels would be discharged into the existing public sanitary sewer system serviced by the City. Therefore, development in the EIR Study Area would not result in the use of septic tanks or alternative wastewater disposal systems.

Additionally, the Public Services and Facilities (PSF) Element of the proposed General Plan addresses public facility and infrastructure needs, such as community safety, water supply, sewer and storm drainage, energy supply, childcare and schools, healthcare and social services, and solid waste. The following General Plan 2040 goal and policies would serve to reduce impacts to sewer facilities:

- **Goal PSF-3:** Maintain sewer, storm drainage, and flood-control facilities adequate to serve existing needs, projected population, and employment growth and that provide protection from climate change risk.
    - **Policy PSF 3.2: Sewer Requirements for New Development.** Require new multifamily and commercial developments to evaluate the main sewer lines in the project vicinity, which will be used by the new development and make any improvements necessary to convey the additional sewage flows.

Compliance with SMMC Chapter 7.38 and the proposed General Plan goal and policy listed above would ensure that potential future development does result in septic tanks or alternative wastewater disposal

systems where soils are not capable of adequately supporting such systems. Therefore, impacts would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-6 The proposed project would not directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

No fossils, unique paleontological resources, or unique geologic features have been recorded in the EIR Study Area. The geology and soils in the EIR Study Area are common throughout the city and region and are not considered to be unique. However, geological formations underlying the EIR Study Area have the potential to contain unique paleontological resources.

Future development would be required to comply with the federal Paleontological Resources Preservation Act, which limits the collection of vertebrate fossils and other rare and scientifically significant fossils to qualified researchers who have obtained a permit from the appropriate state or federal agency, and the California Public Resources Code Section 5097, which prohibits the removal of any paleontological site or feature from public lands without the permission of the jurisdictional agency.

Nevertheless, ground-disturbing construction activities (e.g., grading and excavation) associated with potential future development in the EIR Study Area could uncover fossilized remains of organisms from prehistoric environments that have not been recorded. Adherence to the Society of Vertebrate Paleontology's standards and protocols would ensure the protection of unique paleontological resources during construction of future development.[27] Such protocols include, but are not limited to:

- Excavations within a 50-foot radius of the find shall be temporarily halted or diverted.
- Ground-disturbance work shall cease until a City-approved, qualified paleontologist determines whether the resource requires further study.
- The paleontologist shall document the discovery as needed, in accordance with Society of Vertebrate Paleontology standards (Society of Vertebrate Paleontology 1995) as appropriate, evaluate the potential resource, and assess the significance of the finding under the criteria set forth in CEQA Guidelines Section 15064.5.
- The paleontologist shall notify the appropriate agencies to determine procedures that would be followed before construction activities are allowed to resume at the location of the find.
- If is not feasible, the paleontologist shall prepare an excavation plan for mitigating the effect of construction activities on the discovery. The excavation plan shall be submitted to the City of San Mateo for review and approval prior to implementation.
- All construction activities shall adhere to the recommendations in the excavation plan.

[27] Society of Vertebrate Paleontology, 2010, *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources*, https://vertpaleo.org/wp-content/uploads/2021/01/SVP_Impact_Mitigation_Guidelines.pdf, accessed September 30, 2022.

The Community Design and Historic Resources (CD) Element of the proposed General Plan guides the development and physical form of San Mateo from the individual neighborhood scale to the overall cityscape and includes actions to support preservation of the city's historic resources, including paleontological resources. The following General Plan 2040 goal and policies would serve to reduce impacts to paleontological resources:

- **Goal CD-4:** Protect archaeological and paleontological resources and resources that are culturally significant to Native American tribes and acknowledge San Mateo's past as indigenous land. Encourage development projects to recognize historical tribal lands.
  - **Policy CD 4.6: Paleontological Resource Protection.** Prohibit the damage or destruction of paleontological resources, including prehistorically significant fossils, ruins, monuments, or objects of antiquity, that could potentially be caused by future development.
  - **Action CD 4.9: Paleontological Resource Mitigation Protocol.** Prepare a list of protocols in accordance with Society of Vertebrate Paleontology standards that protect or mitigate impacts to paleontological resources, including requiring grading and construction projects to cease activity when a paleontological resource is discovered so it can be safely removed.

Implementation of the proposed General Plan goal, policy, and action listed above would ensure that impacts from future development under the proposed project would be *less than significant*.

Significance without Mitigation: Less than significant.

GEO-7 The proposed project would not, in combination with past, present, and reasonably foreseeable projects, result in cumulative geology and soils impacts in the area.

The cumulative setting for this analysis includes growth within the EIR Study Area in combination with projected growth in the rest of San Mateo County and the surrounding region. Anticipated development in the EIR Study Area would be subject to regulations pertaining to seismic safety, including the CBC and SMMC requirements. Compliance with these requirements would, to the maximum extent practicable, reduce cumulative, development-related impacts that pertain to seismic shaking, seismic-related ground failure, seismically induced landslides, soil erosion, and unstable soils. Similarly, compliance with relevant SMMC requirements, as well as the requirements of the CBC, would minimize the cumulative impacts associated with substantial erosion or loss of topsoil. While none of the soils in the EIR Study Area are considered to have unique geological resources, unique paleontological resources may occur. Site specific evaluation in the event that previously unknown resources are discovered during construction activities for new development or redevelopment would be required. Future development would be focused on specific sites or areas, which would be evaluated for site development constraints on a case-by-case basis and required to adhere to existing regulations as well as proposed General Plan goals, policies, and actions. Therefore, the proposed project would not result in a cumulatively considerable impact to geology and soils and cumulative impacts would be *less than significant.*

Significance without Mitigation: Less than significant.

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