Appendix 10

Geology and Soils

10 Geology & Soils

10.1 Introduction

This document describes the project's potential effects related to geologic or soil stability hazards, erosion, seismic risk, and/or effects upon local paleontological resources that could be caused by implementation of the project. It should be noted that paleontological resources are also addressed in Chapter 8, Cultural Resources, due to the close relationship between paleontological and cultural resource deposits. Information used to prepare this document came from the following resources:

- Denise Duffy and Associates, *Draft Supplemental Environmental Impact Report for the Proposed Modifications to the Pure Water Monterey Groundwater Replenishment Project*, 2019
- Rincon Consultants, Final *Environmental Impact Report for the Fort Ord Regional Trail and Greenway Project*, 2020
- Kleinfelder, *Geotechnical Evaluation Report for the Monterey Peninsula Light Rail Project*, 2010
- Parsons, *Paleontological Resource Assessment Report for the Monterey Peninsula Light Rail Project*, 2010
- Monterey County, *Monterey County General Plan – Safety Element*, 2010
- U.S. Geological Survey and California Geological Survey Database Reviews

10.2 Environmental Setting

10.2.1 Regional Setting

The project is located within Monterey County, situated in a seismically active area with several faults that transverse the County near the Monterey Peninsula. The project parallels the coastline of Monterey Bay, in and/or adjacent to the cities of Marina, Seaside, Sand City, extending parallel to Highway 1 and Fort Ord Dunes State Park. The project lies within the Coast Ranges geomorphic and physiographic province, which is a region dominated by active tectonics spanning between the Pacific and North American tectonic plates. This region is comprised of discontinuous series of northwest-southeast trending mountain ranges, ridges and intervening valleys characterized by complex folding and faulting.

10.2.2 Project Setting

A geotechnical evaluation report covering the proposed project alignment was conducted in March 2010 as part of previous study analyzing a 17-mile light rail project along the TAMC right-of-way. Environmental, geologic and land use conditions along the current busway project alignment have not significantly changed since 2010.

Topography and Slope Stability

Slope instability or land sliding occurs when the shear strength of the soil within the slope is overpowered by the driving forces within the slope (i.e. ground water, soil weight, seismic shaking). The majority of the project site traverses relatively flat terrain, where landslides and slope instability are not a concern.

Geology

The project lies within the Salinian block, which is one of the major geologic features of the central Coast Ranges. Overlying the granitic basement rocks of the Salinian block are Cretaceous and Tertiary marine and continental sedimentary rocks and occasional Tertiary volcanic rocks. Geologic formations found along the project site are all of Quaternary age and vary from recent and older sand dune deposits to fine-grained alluvial deposits associated with the Salinas Valley (Kleinfelder, 2010). Man-made fills are also present along the project alignment at the south end of the alignment. The units described are presented from youngest to oldest: artificial fill (af), older dune sand (Qod), and marine terrace deposits (Qmt).

The composition of artificial fill materials vary from silt to clay to sand and gravel and in thickness from a few feet to tens of feet. Older dune sand deposits consist of silty sand and poorly graded sand, which are prone to erosion when not stabilized with vegetation. Soil units associated with the older dune sand include the Oceano loamy sand and the Baywood sand (described under Soils). Marine terrace deposits are typically between 2 and 12 feet thick and capped by topsoil. These deposits generally consist of uncemented, friable, thinly laminate to thickly bedded silty very fine to coarse grained sand with pebbles and cobbles. The upper six inches to four feet of the marine terrace deposits are dark brown and clay rich due to topsoil. The base is generally marked in spots by a cobble and pebble rich deposit where the terrace deposits rest on top of the wave-cut platform.

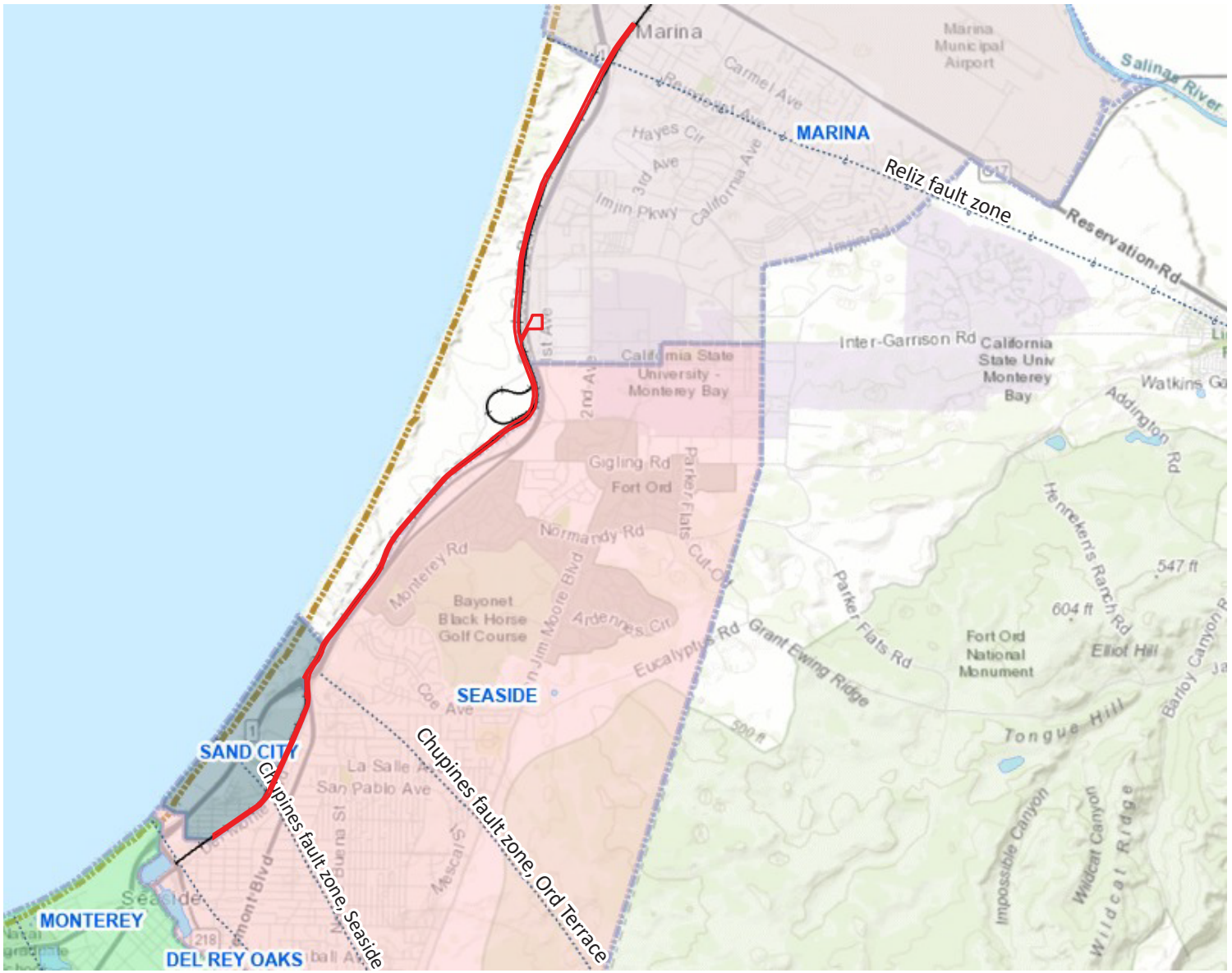
Groundshaking

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the project site and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the project site. Monterey County is subject to very strong (0.3–0.6 g[1]) to severe (greater than 0.6 g) shaking from the San Andreas, San Gregorio, and Reliz/Rinconada Faults (Monterey County, 2008). Earthquakes occurring on faults closest to the project site would most likely generate the largest ground motion. Strong seismic shaking is anticipated to occur during the useful life of the project.

Faults and Seismicity

A number of faults traverse Monterey County near the Monterey Peninsula, including the Chupines Fault, Seaside Fault, Ord Terrace Fault, and Reliz Fault. These faults traverse the project site in a northwest to northeast direction as shown in Figure 10-1. These faults are considered capable of generating earthquakes, but their ground rupture potential is not well established. In general, the surface rupture potential of these faults is poorly constrained and is considered very low to low. The nearest active fault to the project site is the Monterey Bay-Tularcitos Fault located 1.35 mile south of the most southern end of the project alignment. The project site is not located within an Alquist-Priolo Earthquake Fault Zone per the Alquist-Priolo Earthquake Fault Zone map (CA Department of Conservation, 2015).

[1] Shaking in percent gravity is measured in “g”.



Source: Monterey County PBI Mapper, 2021

Figure 10-1: Faults in the Project Area
MST SURF! Busway and Bus Rapid Transit Project

Not to scale

Chupines, Seaside, and Ord Terrace Faults

The Chupines, Seaside, and Ord Terrace Faults are grouped into the Chupines fault zone and is described as a series of right-lateral strike-slip faults with some reverse movement. These faults traverse the southern portion of the project alignment. The Chupines fault zone is approximately 31 miles long. Within the fault zone, several structural folds within the older geologic formations underlying the young and older dune sand deposits have been identified. The potential for ground rupture along these faults is not well established.

Reliz Fault

The Reliz Fault zone traverses the northern portion of the project alignment. This fault is a high-angle reverse fault with about 985 feet of vertical displacement at depth. The fault zone is approximately 48 miles. The Reliz fault is often associated with the Rinconada and King City faults.

Surface Fault Rupture

Fault rupture is the surface displacement that occurs when movement on a fault deep within the earth breaks through to the surface. The Alquist-Priolo Earthquake Fault Zoning Act delineates fault rupture zones approximately 1,000 feet wide, or 500 feet on either side of an active fault trace. Fault rupture and displacement almost always follows preexisting faults, which are zones of weakness; however, not all earthquakes result in surface rupture (i.e., earthquakes that occur on blind thrusts do not result in surface fault rupture. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep).

In addition to damage caused by ground shaking from an earthquake, fault rupture is damaging to buildings and other structures due to the differential displacement and deformation of the ground surface that occurs from the fault offset. This leads to damage or collapse of structures across this zone. Fault rupture displacements in large earthquakes can range from several feet to greater than 15 feet (i.e. displacement on the San Andreas Fault in the 1857 M 7.9 Fort Tejon earthquake was at least 18 feet).

Liquefaction

Liquefaction tends to occur in loose, saturated fine-grained sands, course silts, or clays with low plasticity. The liquefaction process typically occurs at depths less than 50 feet below the ground surface, although liquefaction can occur at deeper intervals, given the right conditions. The most susceptible zone occurs at depths shallower than 30 feet below the ground surface.

For liquefaction to occur, there must be the proper soil type, soil saturation, and cyclic accelerations of sufficient magnitude to progressively increase the water pressures within the soil mass. Non-cohesive soil shear strength is developed by the point-to-point contact of the soil grains. As the water pressures increase in the void spaces surrounding the soil grains, the soil particles become supported more by the water than the point-to-point contact. When the water pressures increase sufficiently, the soil grains begin to lose contact with each other resulting in the loss of shear strength and continuous deformation of the soil where the soil begins to liquefy.

Liquefaction can lead to several types of ground failure, depending on slope conditions and the geological and hydrological settings, of which the four most common types of ground failure are: 1) lateral spreads, 2) flow failures, 3) ground oscillation and 4) loss of bearing strength.

Ground effects related to liquefaction include vertical settlement, ground subsidence, or voids below structures, soil bearing failure, and sandy soils. Areas in Monterey County most susceptible to liquefaction include the Salinas River and floodplain, the Moss Landing and Elkhorn Slough areas, the Carmel River and floodplain, the San Antonio and Lockwood Valleys, and the Peachtree and Cholame Valleys. The project site is not within these areas. As shown in Exhibit 4.4.3 of the Monterey County General Plan EIR, the potential for liquefaction to occur at the project site is low.

Landslides

Landslides are gravity-driven movements of earth materials that may include rock, soil, unconsolidated sediment, or combinations of such materials. The primary factors influencing the stability of a slope are the nature of the underlying soil or bedrock, the geometry of the slope (height and steepness), and rainfall. The presence of historic landslide deposits is a good indicator of future landslides. Landslides are commonly triggered by unusually high rainfall and the resulting soil saturation, by earthquakes, or a combination of these conditions. As shown in Figure 10-2, the project site traverses relatively flat terrain with gentle to low slope gradients. The potential for deep seated land sliding to occur in the bedrock is low to nil.

Lateral Spreading

Lateral spreading is the horizontal movement or spreading of soil toward an open face such as a stream bank or the open side of fill embankments. Lateral spreading and lurching are potential secondary seismic effects commonly associated with liquefaction, where extensional ground cracking and settlement occur as a response to the lateral migration of liquefied material. In the County, the most likely locations to be affected are areas limited to areas proximal to ponds, lakes, channels, and free faces. Because the project alignment is located in an area where there is a low potential for liquefaction, the potential for significant damage from lurch cracking or lateral spreading is low.

Soils

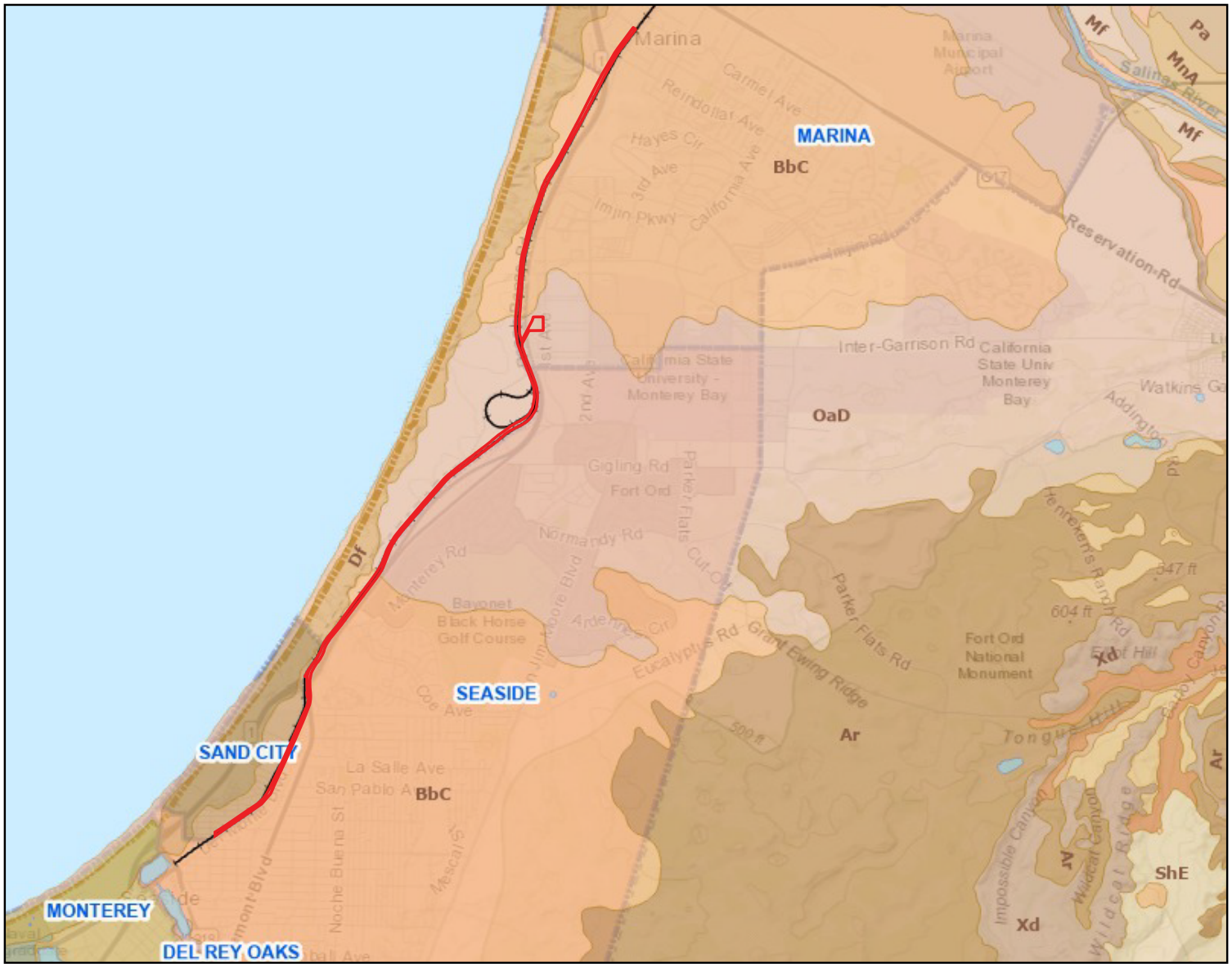
A number of soil properties have important implications for development and resource management. As mapped by the Natural Resources Conservation Service (NRCS), soils in the project area have a moderate to high soil erosion potential. Regional studies conducted by Monterey County indicate the highest rates of erosion are likely to occur where younger and older dune sand deposits are, especially where they are not covered by vegetation.

Based on the NRCS maps, the subsurface profile of the project site generally consists of Baywood sand (2 percent to 15 percent slopes) and Oceano loamy sand (2 percent to 15 percent slopes). See Figure 10-3 for soils in the project area. Both of these units are good for use as roadway fills, but poor for use as sand fill due to excess fines content.

Source: Monterey County PBI Mapper, 2021

Figure 10-2: Landslide Potential in the Project Area
MST SURF! Busway and Bus Rapid Transit Project

Not to scale



Source: Monterey County PBI Mapper, 2021

Figure 10-3: Soils in the Project Area
MST SURF! Busway and Bus Rapid Transit Project

Not to scale

Regarding expansive soils, these soils can change dramatically in volume depending on moisture content. The amount of moisture content can trigger a shrink-swell phenomenon. Expansive soils are typically very fine-grained with a high to very high percentage of clay. Clay minerals present in expansive soils typically include ontmorillonite, smectite, and/or bentonite. Both Baywood and Ocean Series are composed of sand and have low water storage potential. The project site has a low potential for soil expansion and low shrink-swell potential.

Paleontological Setting

Paleontological resources are nonrenewable scientific and educational resources, typically consisting of fossilized plants and animals. Projects subject to CEQA must determine whether a project would "directly or indirectly destroy a unique paleontological resource."

A paleontological resources assessment covering the proposed project alignment was conducted in 2010 as part of the previous study analyzing a 17-mile light rail project along the TAMC right of way. Environmental and land use conditions along the current busway project alignment have not significantly changed since 2010.

As part of the assessment, a museum records search was conducted at the University of California Museum of Paleontology (UCMP) on October 18, 2010 to assess the potential for any paleontological resources that may be adversely affected by the 17-mile light rail project along the TAMC right of way. The results of the search identified that the project site is located on Miocene, Pleistocene, and Holocene geologic units. The UCMP records search revealed two vertebrate fossil localities in the City of Monterey, none of which are within the project site. However, the results of the assessment indicated areas mapped as being underlain with Holocene-age alluvial deposits has a paleontological sensitivity of low to high with increasing depth.

10.3 Applicable Regulations, Plans, and Standards

10.3.1 Federal

International Building Code

Published by the International Code Council, the scope of this code covers major aspects of construction and design of structures and buildings, except for 3-story one- and two-family dwellings and town homes. In 2000, the 1997 Uniform Building Code was replaced by the International Building Code (IBC) and contains provisions for structural engineering design. Published by the International Conference of Building Officials, the 2018 IBC addresses the design and installation of structures and building systems through requirements that emphasize performance. The IBC includes codes governing structural as well as fire- and life-safety provisions covering seismic, wind, accessibility, egress, occupancy, and roofs.

10.3.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act, Public Resources Code (PRC), Section 2621-2630 (formerly the Special Studies Zoning Act), regulates development and construction of buildings intended for human occupancy to avoid the hazard of surface fault rupture. This Act categorizes faults as active, potentially active, and inactive. Historic and Holocene age faults are considered active, Late Quaternary

and Quaternary age faults are considered potentially active, and pre-Quaternary age faults are considered inactive. These classifications are qualified by the conditions that a fault must be shown to be "sufficiently active" and "well defined" by detailed site-specific geologic explorations to determine whether building setbacks should be established.

The Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act, PRC, Sections 2690–2699, of 1990 directs the California Department of Conservation, Division of Mines and Geology [now called California Geological Survey (CGS)] to delineate Seismic Hazard Zones. The purpose of the act is to reduce the threat to public health and safety and to minimize the loss of life and property by identifying and mitigating seismic hazards.

Cities, counties, and State agencies are directed to use seismic hazard zone maps developed by CGS in their land-use planning and permitting processes. The act requires that site-specific geotechnical investigations be performed prior to permitting most urban development projects within seismic hazard zones.

California Building Standards Code

The California Building Code (CBC) is another name for the body of regulations known as the California Code of Regulations (CCR), Title 24, Part 2, which is a portion of the California Building Standards Code and establishes minimum requirements for a buildings structural strength and stability to safeguard the public health, safety and general welfare. Title 24 is assigned to the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. Under state law, all building standards must be centralized in Title 24 or they are not enforceable.

Published by the International Conference of Building Officials, the Uniform Building Code (UBC) is a widely adopted model building code in the United States. The CBC incorporates by reference the 2006 International Building Code, with necessary California amendments.

10.3.3 Local

Grading and Soil Stability Regulations

Monterey County Code - Chapter 16.08 (Grading Ordinance)

The County grading ordinance generally regulates grading involving more than 100 cubic yards of excavation and filling. Minor fills and excavations (cuts) of less than 100 yards that are not intended to provide foundation for structures, or that are very shallow and nearly flat, are typically exempt from the ordinance, as are shallow footings for small structures. Submittal requirements for a County grading permit include site plans, existing and proposed contour changes, an estimate of the volume of earth to be moved, and geotechnical (soils) reports. Projects involving grading activities over 5,000 cubic yards must include detailed plans signed by a State-licensed civil engineer.

In addition to grading ordinance provisions, the Code details specific regulations for development on slopes in excess of 30 percent, including conformance with the grading ordinance and erosion control requirements. Specific geotechnical or engineering geologic investigation requirements include the following:

1. Presentation of data regarding the nature, distribution, and strength of existing soils.
2. Recommended grading procedures and design criteria for corrective measures when necessary, including buttress fills.
3. Examination and recommendations to maintain slope stability.
4. Description of the site geology of the site and the effect of geologic conditions on the proposed development.
5. Incorporation of approved report recommendations in the grading plans and specifications. (Ord. 2535 110, 1979.).
6. Completion of a liquefaction study, where applicable and the potential for liquefaction, should there be:
    a) Shallow ground water at 50 feet (15.24 meters) or less,
    b) Unconsolidated sandy alluvium,
    c) Site within Seismic Zone 4.

Monterey County Code - Chapter 16.12 (Erosion Control Ordinance)

Chapter 16.12 of the Monterey County Municipal Code prohibits development on slopes greater than 30 percent, requiring completion of an Erosion Control Plan, control of runoff, avoiding creek disturbance, regulating land clearing, and prohibiting grading activities during the winter. The Erosion Control Ordinance is enforced by the County Director of Building Inspection.

City of Marina - Chapter 15 (Buildings and Construction)

Chapter 15 of the Marina Municipal Code adopts the CBC by reference and covers requirements for seismic safety. As part of the approval process, projects in the City must prepare a soils report prepared by a registered geotechnical engineer that includes test borings upon which the report is based and recommended corrective actions, where necessary. Also, erosion control and improvements to be constructed are required as a part of the construction permit application process.

City of Seaside Municipal Code

Section 15.32.180 (Design standards – Erosion and sediment control)

Section 15.32.180 of the Seaside Municipal Code contains design standards for erosion and sediment control related to slopes, runoff control, building site runoff, vegetation removal, vegetation disposal, topsoil, temporary vegetation, winter operations, dust, erosion control coordination with project installation, livestock, and maintenance.

Section 15.32.090 (Permit – Application – Engineering reports required)

Section 15.32.090 of the Seaside Municipal Code requires either a soil engineering report or engineering geology report for excavation, grading, filling, clearing, and/or erosion control work permits which are required to include recommendations for seismic and erosion control.

Section 15.32.070 (Permit – Application – Plans and specifications required)

Section 15.32.070 of the Seaside Municipal Code requires permit applications to include vegetation erosion control and revegetation measures for all surfaces exposed or expected to be exposed during grading activities as part of overall erosion and sediment control plans

City of Sand City - Chapter 15 (Buildings and Construction)

Chapter 15 of the Sand City Municipal Code adopts the CBC by reference and covers requirements for seismic safety.

Monterey Multi-Jurisdictional Hazard Mitigation Plan

The cities of Marina, Seaside and Sand City currently participate in the Monterey County Multi-Jurisdictional Hazard Mitigation Plan. The Plan incorporates hazard mitigation principles, practices, and functions for the County and cities participating in the plan. Recommended specific actions designed to protect people and the community from losses related to hazards are identified in the Plan.

10.4 Environmental Impacts and Mitigation Measures

10.4.1 Significance Criteria

The following significance criteria for geology and soils were derived from the Environmental Checklist in CEQA Guidelines Appendix G. These significance criteria have been amended or supplemented, as appropriate, to address lead agency requirements and the full range of impacts related to the proposed project.

An impact of the proposed project would be considered significant and would require mitigation if it would meet one of the following criteria.

- 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. Refer to Division of Mines and Geology Special Publication 42.
    ii) Strong seismic ground shaking
    iii) Landslides
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on-or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- 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.
- Result in soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water.

- Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

10.4.2 Summary of No and/or Beneficial Impacts

On-site Wastewater Disposal System

The proposed project would not require the extension or installation of wastewater connections as this service is not essential to busway operations. However, should restrooms be required for the 5th Street Station in the future, MST would seek water and wastewater connections from the City of Marina. No on-site waste water disposal system is proposed at this time and any future construction would be subject to separate environmental review. Therefore, there would be no impact associated with an on-site wastewater disposal.

10.4.3 Impacts of the Proposed Project

Impact GEO-1: The project would not 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. This is a **less-than-significant impact**.

Construction

The project site is not located within an Alquist-Priolo Earthquake Fault Zoning Map as mapped by the State Geologist. As indicated above, there are four faults that cross the project alignment: the Chupines Fault, Seaside Fault, Ord Terrace Fault, and Reliz Fault. Although these faults are not zoned by the State as active, there is evidence of probable offshore extension of the Chupines Fault displacing Holocene-age (less than 11,000 years old) deposits and sea floor sediment.[2] However, because the majority of these faults have not exhibited Holocene displacement and are not considered sufficiently active or well-defined, the potential is very low that the individual traces of these faults could generate an earthquake and result in surface fault rupture. Thus, would be no impacts associated with fault rupture during construction.

Operation

As mentioned above, the project site is not located within an Alquist-Priolo Earthquake Fault Zoning Map as mapped by the State Geologist. While there are four faults that cross the project alignment, the potential for these faults to generate an earthquake and result in surface fault rupture is very low. The closest known active fault to the project site is the Monterey Bay-Tularcitos Fault Zone, located approximately 1.35 miles south of the most southern end of the project alignment. Given the project's location, this impact is less than significant.

[2] ESA. 2018. Final EIR/EIS for the CalAM Monterey Peninsula Water Supply Project, page 4.2-57.

Impact GEO-2: The proposed project could be subject to strong seismic ground shaking during a seismic event. This is a **less-than-significant impact.**

Construction and Operation

Four faults cross the project alignment, however, none of these faults are currently considered active and their potential for surface-rupture is considered very low to low. The largest ground motion would likely be the result of movement along the Monterey Bay-Tularcitos Fault. Due to a maximum probable magnitude earthquake along this fault and the respective distances to the project site, seismic shaking is anticipated to occur during the design and operational life of the project. However, the project is primarily a roadway project, and would be required to be designed and constructed to withstand substantial ground shaking in order to minimize seismic impacts. The structural elements of the project would undergo appropriate design-level geotechnical evaluations prior to final design and construction and be subject to

CBC seismic design force standards for the cities of Marina, Seaside, and Sand City and Monterey County (for buildings and similar features) per Chapter 18.02 of the County Municipal Code. Compliance with these standard conditions would ensure that the busway and associated project structures (e.g. 5th Street Station, platforms, and retaining walls) would be constructed to withstand expected seismic activity and associated potential hazards, such as a significant seismic event. The required compliance with applicable CBC standards for the cities of Marina, Seaside, and Sand City and Chapter 18.02 of the County Municipal Code would reduce impacts to a less-than-significant level. No further project specific mitigation is required.

Impact GEO-3: The project's susceptibility to landslide conditions is low. Risk of landslide is a **less-than-significant impact.**

Construction and Operation

The majority of the project alignment traverses relatively flat terrain on existing roadways or adjacent to existing railroad tracks, where landslides and slope instability are not a concern. Based on a search of the California Department of Conservation Landslide Inventory, the project site has gentle to low slope gradients. The potential for deep seated land sliding to occur in the bedrock is low to nil.

The project would be subject to CBC standards for the cities of Marina, Seaside, and Sand City and Section 18.02 of the County Municipal Code, which would ensure that the structures and associated improvements are designed and constructed to withstand potential hazards, such as landslides. Compliance with CBC standards for the cities of Marina, Seaside, and Sand City and Section 18.02 of the County Municipal Code would ensure that the busway structures and associated improvements are designed and constructed to withstand potential hazards and would adequately address any slope instability concerns.

Impact GEO-4: The project could result in soil erosion or the loss of topsoil. This impact is considered **less-than-significant impact.**

Construction and Operation

As discussed above, the soils at the project site have a moderate to high soil erosion potential. Regional studies conducted by Monterey County indicate the highest rates of erosion are likely to occur where younger and older dune sand deposits are, especially where they are not covered by vegetation. The majority of the project site is on existing hardscaped railway and is surrounded by coastal vegetation. The southern end of the project site from California and Orland Street is surrounded by hardscape surfaces, limiting the potential for downstream/off-site erosion impacts on neighboring property. Because the project site is already in a developed area and surrounded by vegetation, there is a lower potential for off-site erosion impacts to occur during construction.

During construction, the proposed project would involve the localized removal of topsoil and earth-moving activities, such as excavation, grading, soil compaction and moving, and stockpiling of soils associated with the construction of busway lanes, bike paths, and parking. Although the project is relatively flat, the loosening and exposure of soil would make the project site susceptible to erosion by rainfall and wind during the construction phase. Compared to areas of deep sedimentary soils or farmed land, loss of topsoil at the project is less of a concern. While the project could result in temporary erosion impacts during construction, the project would be required to comply with standard construction practices during all construction and operational phases of the project to prevent and minimize construction-related erosion.

As discussed further in **Chapter 13, Hydrology and Water Quality**, the project – during all phases of construction and operation – must comply stringent erosion control measures and construction best management practices to meet County and cities of Marina, Seaside, and Sand City water quality requirements related to discharges into the Monterey Bay. Compliance with standard permit requirements and regulations would mitigate potential erosion impacts to a less than significant level.

Impact GEO-5: The project is located on a geologic unit or soil that could be either unstable, or that could become unstable as a result of the project, and potentially result in on-or off-site landslide, lateral spreading, subsidence, liquefaction, collapse or expansive soils. This impact is considered **less than significant with mitigation incorporated.**

As described in the previous geotechnical report covering the proposed project alignment, the project site is located on soils that are good for use as roadway fills and firm overburden soils that are suitable for foundation support. However, the potential for soil erosion is high in areas where younger and older dune sand deposits are, especially if not covered by vegetation. While the geologic unit below the project is very stable, the site is nonetheless subject to common risks associated with the local soils.

Landslides

Please see Impact GEO-3 above.

Liquefaction and Subsidence

Ground effects related to liquefaction include vertical settlement, ground subsidence or voids below structures, soil bearing failure, and sand boils. As shown in Exhibit 4.4.3 of the Monterey County General Plan EIR, the potential for liquefaction to occur at the project site is low.

Lateral spreading

Lateral spreading is a potential secondary seismic effect commonly associated with liquefaction, where extensional ground cracking and settlement occur as a response to the lateral migration of liquefied material. In Monterey County, the most likely locations to be affected by lateral spreading are areas limited to areas proximal to ponds, lakes, channels, and free faces. As the project site does not cross any of these areas and there is a low potential for liquefaction, the potential for lateral spreading to occur is low.

Regardless, the project would be subject to CBC standards for the cities of Marina, Seaside, and Sand City and Section 18.02 of the County Municipal Code, which would ensure that the structures and associated improvements are designed and constructed to withstand potential hazards, such as lateral spreading. Compliance with CBC standards for the cities of Marina, Seaside, and Sand City and Section 18.02 of the County Municipal Code in the project design would reduce potential impacts to a less-than-significant level.

Collapse

Strong seismic shaking is anticipated to occur during the useful life of the project. To mitigate the shaking effects, all structures would be required to comply with the CBC requirements for the cities of Marina, Seaside, and Sand City and Chapter 18.02 of the County Municipal Code as a minimum. Compliance with CBC requirements for the cities of Marina, Seaside, and Sand City and Chapter 18.02 of the County Municipal Code the project design would reduce potential impacts to a less-than-significant level.

Expansive Soils

As discussed above, the subsurface profile of the site generally consists of Baywood sand and Oceano loamy sand. Based on a review of environmental databases, soils in the project site, both Baywood and Ocean Series are composed of sand and have low water storage potential and a low potential for expansion. Thus, impacts would be less than significant.

It should be noted that an updated geotechnical evaluation is being prepared during the final design phase to evaluate the current subsurface conditions of the proposed project site and develop conclusions and recommendations on the project from a geotechnical and geological standpoint. The project would also be required to incorporate recommended engineering measures from the updated geotechnical evaluation as appropriate. With implementation of Mitigation Measure (MM) GEO-5 and adherence to local building standards, City engineering standards, the site's geologic and soil constraints would be fully addressed through construction-level geotechnical recommendations and compliance with all applicable codes and regulations, potential impacts related to unstable soils would be reduced to a less-than-significant level.

MM GEO-5 Final Geotechnical Evaluation

A construction level geotechnical evaluation shall be prepared and implemented for the project based on the final engineering plans. The project shall be required to adhere to and incorporate all standards and recommended engineering measures to mitigate for liquefaction, expansive soils and other local soil constraints. The final geotechnical evaluation will be prepared by MST and provided to the affected land use agencies for review prior to the issuance of local building permits or related local approvals.

Impact GEO-6: The project could directly or indirectly destroy a unique paleontological resource or site or unique geologic features during construction. This impact is considered **less than significant with mitigation incorporated.**

Construction and Operation

Based on the previous paleontological resource assessment covering the proposed project alignment, no paleontological resources were identified within the project alignment. The likelihood of encountering unique paleontological resources was determined to be low to high with increasing depth. Because there is the potential to uncover paleontological resources in previously undisturbed portions of the project area, ground disturbing activities during construction could potentially result in significant impacts to paleontological resources.

Mitigation measures MM CR-1 and MM CR-2 recognize the need for all construction personnel involved in project-related ground disturbances to be provided archaeological and paleontological sensitivity training. Training would include procedures for inadvertent discovery during ground disturbing activities. Implementation of these measures identified in Chapter 8 would effectively mitigate potential effects to paleontological resources by requiring a qualified cross-trained monitor to be present during any construction activities that involve excavations.

No further mitigation is warranted.

10.4.4 Cumulative Impact Analysis

Because geologic impacts are site-specific and highly dependent upon the structural characteristics of individual projects, cumulative geologic hazards and soils impacts are generally confined to the project site and immediate vicinity.

Impact GEO-7: The project would not contribute to cumulatively considerable effects on geology and soils. This is a **less-than-significant impact**.

Most geologic-related impacts from development are site-specific and, if properly designed, would not result in worsening of the environment or adversely affect public health and safety. Cumulative development projects would be subject to site-specific geologic and/or soils constraints. Pursuant to requirements of the cities of Marina, Seaside, and Sand City and County requirements, and as recognized in the General Plan EIRs adopted in these communities, a registered geotechnical engineer would investigate site-specific conditions and minimize exposure to hazards or constraints with implementation of the resulting recommendations.

Cumulative development could also potentially involve the exposure of an increased number of people and/or structures to risk of earthquakes and their associated geologic hazards. However, the project consists of busway travel lanes, and all new construction would be required to comply with the most current CBC, which establishes building standards to minimize risk based on the geologic and seismic conditions of the region in which a project is located.

With administration of these requirements, the implementation of City and County Ordinances and Policies and adherence to CBC requirements, the project would not have a cumulatively considerable contribution to cumulative geologic, soils, seismic hazards or paleontological resource impacts.

10.5 References

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