3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION MEASURES

3.9 Geology, Soils, Seismicity, and Paleontological Resources

PURPOSE

Geology, Soils, Seismicity, and Paleontological Resources

Geology, soils, and seismicity are factors that often determine the design criteria for the development of passenger rail projects, particularly when grade separation structures are involved. This section summarizes the geologic materials, paleontological resources, faults, seismic characteristics, and other subsurface conditions of the project.

3.9.1 Introduction

Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources (GSSPR), of the Los Angeles to Anaheim Project Section (project section) Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) discusses the potential impacts of the No Project Alternative and the High-Speed Rail (HSR) Project Alternatives, otherwise called Shared Passenger Track Alternative A and Shared Passenger Track Alternative B, and describes impact avoidance and minimization features (IAMF) that will avoid, address, or reduce these impacts. Section 3.9 also defines the geology, soils, and paleontological resources within the region and describes the affected environment in the resource study areas (RSA).

The following technical report, available on request, serves as the basis for the geologic resources and geologic hazards information in this section:

- *Los Angeles to Anaheim Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2025a)

The following technical report, available on request, provides additional technical details for paleontological resources:

- *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b)

Additional details on GSSPR are provided in the following appendix in Volume 2 of this Draft EIR/EIS:

- Appendix 2-A, Impact Avoidance and Minimization Features
- Appendix 3.1-A, Regional and Local Policy Inventory and Consistency Analysis

This section includes detailed analysis of environmental resources, affected environment, environmental consequences, and mitigation measures based on the *Project Environmental Impact Report/Environmental Impact Statement Environmental Methodology Guidelines*, Versions 5.9 and 5.11 (Authority 2017, 2022) as amended.

Seven other resource sections in this Draft EIR/EIS provide additional information related to GSSPR.

- **Section 3.6, Public Utilities and Energy:** Construction and operational changes caused by the Shared Passenger Track Alternatives regarding conflicts between existing high-pressure natural gas lines and the project.
- **Section 3.7, Biological Resources and Wetlands:** Construction and operational changes caused by the Shared Passenger Track Alternatives on wetlands and surface waters in the biological resources and wetlands RSA.
- **Section 3.8, Hydrology and Water Resources:** Construction and operational changes caused by the Shared Passenger Track Alternatives related to contamination of surface water and groundwater resources, as well as natural phenomena such as flooding.

- **Section 3.10, Hazardous Materials and Wastes:** Construction and operational changes caused by the Shared Passenger Track Alternatives related to contamination of soils and groundwater, dewatering permits, spill prevention, and other best management practices (BMP).
- **Section 3.11, Safety and Security:** Construction and operational changes caused by the Shared Passenger Track Alternatives on emergency response preparedness in the event of leaks, spills, or accidents involving hazardous materials and wastes and construction impacts related to oil and gas wells.
- **Section 3.17, Cultural Resources:** Construction and operational changes caused by the Shared Passenger Track Alternatives on unknown subsurface archaeological resources.
- **Section 3.19, Cumulative Impacts:** Construction and operational changes caused by the Shared Passenger Track Alternatives and other past, present, and reasonably foreseeable future projects.

3.9.1.1 Definition of Resources

The following are definitions for GSSPR analyzed in this Draft EIR/EIS.

Geologic Resources

- **Soil Hazards:** Soil hazards present in the RSA include expansive soils, erodible soils, collapsible soils, and corrosive soils.
  - **Expansive soils:** Expansive soils are susceptible to expansion and contraction resulting from changes in moisture and provide an unstable support for foundations or other structures.
  - **Erodible soils:** Erodible soils are susceptible to wind and water erosion. Water erosion can occur from runoff or raindrop impact. Wind erosion can occur through sustained winds or strong gusts.
  - **Collapsible soils:** Collapse can occur in dry, granular soils that have an unstable soil structure because of deposition or irrigation processes, typically with a skeletal structure that is weakly cemented by soluble salts or clay. Increases in moisture content can cause the interparticle cementation to reduce, causing changes in volume (collapse), especially when loaded.
  - **Corrosive soils:** Corrosive soils have chemical properties that weaken concrete or uncoated steel and thereby reduce the design life of the structure. Corrosion, if not accounted for in the project's design, can weaken structures built on corrosive soils, potentially causing structural failure.
- **Geologic Hazards:** Geologic hazards such as landslides, slumps, and land subsidence pose potential threats to people and property.
  - **Landslides:** A landslide refers to the downslope movement of materials such as rock, soil, or fill under the direct influence of gravity. Landslides include rockslides, debris flows, slumps, rock falls, and topple failures. Landslides are caused by several influences and factors related to slope stability, including slope angle, weathering, climate, water content, vegetation, overloading, erosion, earthquakes, and human-induced factors. Landslides are caused by the dynamic factors listed above, but they are usually triggered by the addition of weight to the top of a potential slide area, removal of mass from the base of a potential slide area, increases in the volume of water within a potential slide area, and vibrations from earthquakes.
  - **Subsidence:** Subsidence is the vertical displacement of the ground surface, which can be localized, or over a broad region. Subsidence may be affected by different processes at work and can be naturally induced or human-induced. Regional-scale, human-induced subsidence generally results from withdrawal of fluids (water, oil, or gas) from underground reservoirs.

- **Primary Seismic Hazards:** Primary seismic hazards include ground surface fault ruptures and ground shaking.
  - **Surface Fault Rupture:** Surface fault rupture refers to the extension of a fault to the ground surface by which the ground breaks, resulting in an abrupt relative ground displacement (e.g., vertical or horizontal offset). Surface fault ruptures are the result of stresses relieved during an earthquake event and often cause damage to structures astride the fault zone. A fault zone is a group of earthquake-induced fractures in soil or rock where there has been documented seismic displacement on two sides of the fault relative to one another.
  - **Ground Shaking:** Ground shaking is the level of ground movement caused by a seismic event. Ground shaking occurs when energy released during a fault rupture then travels through subsurface rock, sediment, and soil materials, resulting in motion experienced at the ground surface. Ground shaking intensity varies with the earthquake magnitude (M), the distance from the earthquake epicenter, and the type(s) of geologic substrate the seismic waves move through. Depending on the level of ground motion and the soil stiffness, the ground shaking can amplify or de-amplify.
- **Secondary Seismic Hazards:** Secondary seismic hazards include liquefaction, seismically induced settlements, lateral spreads or slumps, landslides, and flooding resulting from seismically induced dam failure.
  - **Liquefaction:** Liquefaction is a phenomenon in which loose to medium-dense, saturated, granular materials undergo matrix rearrangement, develop high pore water pressure, and lose shear strength because of cyclic ground vibrations induced by earthquakes. This rearrangement and strength loss are followed by a reduction in bulk volume of the liquefied soils. The effects of liquefaction can include the loss of bearing capacity below foundations, settlement in level ground, and instability in areas of sloping ground (also known as lateral spreading). Liquefaction generally has the potential to cause surface expression when it occurs within 50 feet of the ground surface. However, liquefaction may occur at depths greater than 50 feet in poorly consolidated deposits that have a loose to medium density.
  - **Seismically Induced Settlement:** Strong ground motion can cause the densification of soils, resulting in ground surface settlement. This phenomenon, known as seismically induced settlement or seismic compaction, typically occurs in dry, loose, cohesionless soils, but may also occur in saturated soils. During an earthquake, soil grains may become more tightly packed because of the collapse of voids or pore spaces, resulting in a reduction in the soil column thickness.
  - **Lateral Spreading:** Lateral spreading and flow slides are phenomena where surficial soil displaces along a shear zone that has formed within an underlying liquefied layer. On reaching mobilization, the surficial blocks are transported downslope or in the direction of a free face by earthquake and gravitational forces. Lateral spreading is thought to occur on slopes as level as 0.5 percent, or on level ground with a “free face,” such as a stream bank. Flow slides occur when conditions are favorable for liquefaction to occur and lead to a state of unlimited flow. A contributing factor to lateral spreading and flow slides is the presence of stratified soil in which pore pressures build up within potentially liquefiable layers that are confined by lower-permeability soil layers. This can result in substantial reductions in shear strength and large, lateral deformations and flow failures.
- **Areas of Difficult Excavation:** Difficult excavation is defined as excavation methods that require more than standard earthmoving equipment or special controls to enable work to proceed. Areas of difficult excavation are most common in bedrock formations, and possibly cemented or hardpan strata not amenable to excavation with a ripper-equipped dozer. Cemented zones and hardpan form because of the soil-weathering processes.
- **Mineral Resources:** Mineral resources include resources used for building (i.e., aggregate); industrial minerals such as lime, pumice, and gypsum; and fossil fuels and geothermal resources.

Paleontological Resources

- **Paleontological Resources:** Paleontological resources are the preserved remains or traces of animals and plants. They include body fossils (the remains of the organism itself) and trace fossils (which record the presence and movement of past organisms in their environment). Fossils are typically found in sedimentary and certain types of volcanic rock units, and they provide information about the evolution of life on Earth over the past approximately 4 billion years. Paleontological resources are important to science and education because they document the presence and evolutionary history of specific groups of organisms, reconstruct the environments in which these organisms lived, provide information on the age of the rocks in which they are found, and offer insight into environmental change over time.

Resources not Discussed Further

The following topics are not discussed further in this section of the Draft EIR/EIS because they do not present a risk or would not result in a change from baseline conditions:

- **Tsunami:** A tsunami is an ocean wave that develops as a result of the displacement of large amounts of water over a short period of time. Tsunamis are commonly associated with sub-marine faults that displace water in the ocean over long distances. The effect of a tsunami on a shoreline is closely associated with the bathymetric properties of an ocean basin. Tsunamis can also occur as a result of sub-marine as well as land-based landslides, which can displace large volumes of water over a short period of time. Because of the project's distance from the ocean, tsunamis do not present a potential hazard to the project section. Therefore, tsunamis are not discussed further.
- **Volcanic Activity:** The nearest volcanic source is more than 150 miles from the project section. Additionally, the risk of volcanic activity is low. Therefore, volcanic activity is not discussed further.
- **Borrow Sites:** The project would require substantial quantities of imported aggregate material for use as track ballast and sub-ballast, and for aggregate in concrete construction. The project alignment would require approximately 740,000 cubic yards (equivalent to about 1.1 million tons) of aggregate for at-grade ballasted track. The aggregate may come from a variety of sources, both regional and out of state, depending on project schedule needs and aggregate availability. According to the California Geological Survey (CGS) (Clinkenbeard and Guis 2018), the combined production-consumption-regions of the local San Gabriel and Temescal Valley areas produced over 10 million tons of aggregate in 2016. In the Southern California region, the Temescal Valley/Orange County production-consumption-region has the greatest quantity of aggregate availability. The Temescal Valley/Orange County production-consumption-region had 862 million tons of permitted reserves as of 2017 with a 50-year demand of 1.08 billion tons. This equates to a range of 41 to 50 years of permitted reserves remaining in just this one production-consumption region. The availability of this local production-consumption region to provide the aggregate needs depends on project schedule and aggregate production rates. Therefore, there may be an out-of-state need to consider sources beyond what is regionally available, including potential out of state sources. However, construction of the project would not substantially reduce the availability of mineral resources in the Southern California production-consumption regional area, provided that all available sources of aggregate are considered during the construction period. Therefore, borrow sites are not evaluated in the analysis of geology, soils, and seismicity.
- **Rock Fall and Steep Slopes:** None of the components is in an area of steep slopes or where rock fall is likely. Therefore, impacts related to rock fall and steep slopes are not discussed further.

3.9.2 Laws, Regulations, and Orders

This section describes the federal, state, and local laws, regulations, orders, and plans applicable to GSSPR. General National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements for assessment and disclosure of environmental impacts are described in Section 3.1, Introduction, and are therefore not restated in this resource section. NEPA and CEQA requirements specific to the evaluation of GSSPR are described in this section.

3.9.2.1 Federal

NEPA, as amended (42 U.S. Code Section 4321 et seq.)

As with cultural resources, NEPA recognizes the continuing responsibility of the federal government to "preserve important historic, cultural, and natural aspects of our national heritage" (Sec. 101 [42 U.S. Code 4321]) (#382). With the passage of the Paleontological Resources Preservation Act (2009), paleontological resources are considered to be significant resources, and it is therefore now standard practice to include paleontological resources in NEPA studies in instances where there is a possible impact.

NEPA requires the consideration of potential environmental effects—including potential effects on geology, soils, and geologic resources—in the evaluation of a proposed federal agency action.

Federal Railroad Administration, Procedures for Considering Environmental Impacts (64 *Federal Register* 28545)

On May 26, 1999, the Federal Railroad Administration (FRA) released *Procedures for Considering Environmental Impacts* (FRA 1999). These FRA procedures describe the FRA's process for assessing the environmental impacts of actions and legislation proposed by the agency and for the preparation of associated documents (42 U.S. Code 4321 et seq.). The FRA Procedures for Considering Environmental Impacts states that "the EIS should identify any significant changes likely to occur in the natural environment and in the developed environment. The EIS should also discuss the consideration given to design quality, art, and architecture in project planning and development as required by U.S. Department of Transportation Order 5610.4." These FRA procedures state that an EIS should consider possible impacts on energy and mineral resources.

American Antiquities Act of 1906 (16 U.S. Code Sections 431 to 433)

The American Antiquities Act was enacted with the primary goal of protecting cultural resources in the U.S. Therefore, it prohibits appropriation, excavation, injury, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity" on lands owned or controlled by the federal government. The act also establishes penalties for such actions and sets forth a permit requirement for collection of antiquities on federally owned lands.

Neither the American Antiquities Act itself nor its implementing regulations (43 Code of Federal Regulations [CFR] Part 3) specifically mentions paleontological resources. However, many federal agencies have interpreted objects of antiquity as including fossils. Consequently, the American Antiquities Act represents an early cornerstone for efforts to protect the nation's paleontological resources.

Paleontological Resources Preservation Act (16 U.S. Code Section 470)

Enacted as part of the Omnibus Public Land Management Act (2009), the Paleontological Resources Preservation Act requires the Secretaries of the Interior and Agriculture to manage and protect paleontological resources on federal land using scientific principles and expertise. The Paleontological Resources Preservation Act includes specific provisions addressing management of these resources by the Bureau of Land Management, the National Park Service, the Bureau of Reclamation, the U.S. Fish and Wildlife Service, and the U.S. Forest Service of the Department of Agriculture. The Paleontological Resources Preservation Act affirms the authority for many of the policies the federal land managing agencies already have in place for the management of paleontological resources, such as issuing permits for collecting paleontological resources, curation of paleontological resources, and confidentiality of locality data.[1]

Federal Occupational Safety and Health Administration Regulations

CFR Title 29, Part 1926, Part 1926.650 et seq. details the Occupational Safety and Health Administration's requirements for excavation and trenching operations. The Occupational Safety and Health Administration issued its first standards related to excavation and trenching operations in 1971 and has since updated the standards to further reduce risk of injury and accidents, including regulatory requirements that address construction-related gas monitoring and risk factors associated with subsurface gas hazards.

3.9.2.2 State

Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code, Section 2621 et seq.)

This act provides policies and criteria to assist cities, counties, and state agencies in the exercise of their responsibilities to prohibit the location of developments and structures for human occupancy across the trace of active faults. The act also requires site-specific studies by licensed professionals for some types of proposed construction within delineated earthquake fault zones.

Seismic Hazards Mapping Act (California Public Resources Code, Sections 2690–2699.6)

This act requires that site-specific hazards investigations be conducted by licensed professionals within the zones of required investigation to identify and evaluate seismic hazards and formulate mitigation measures prior to permitting most developments designed for human occupancy.

Geologic Hazard Abatement Districts (California Public Resources Code, Division 17, Subsections 26500–26654)

The Beverly Act of 1979 (Senate Bill 1195) established Geologic Hazard Abatement Districts and allowed local residents to collectively mitigate geological hazards that pose a threat to their properties. Geologic Hazard Abatement Districts may be formed for the following purposes: prevention, mitigation, abatement, or control of a geologic hazard; and mitigation or abatement of structural hazards that are partly or wholly caused by geologic hazards. The California Public Resources Code Section 26507 defines a *geologic hazard* as "an actual or threatened landslide, land subsidence, soil erosion, earthquake, fault movement, or any other natural or unnatural movement of land or earth."

Surface Mining and Reclamation Act (California Public Resources Code, Section 2710 et seq.)

This act addresses the need for a continuing supply of mineral resources and is intended to prevent or minimize the adverse impacts of surface mining on public health, property, and the environment. The act also assigns specific responsibilities to local jurisdictions in permitting and oversight of mineral resources extraction activities.

California Building Standards Code (California Public Resources Code, Title 24)

The California Building Standards Code governs the design and construction of buildings, associated facilities, and equipment, and applies to buildings in California.

Oil and Gas Conservation (California Public Resources Code, Sections 3000–3473)

The California Geologic Energy Management Division (CalGEM) within the Department of Conservation oversees the drilling, operation, maintenance, and plugging and abandonment of

[1] U.S. Department of the Interior, Bureau of Land Management, Heritage Resources. Internet page titled Laws & Policy, at www.blm.gov/wo/st/en/prog/more/CRM/paleontology/paleontological_regulations.print.html on 8/14/13.

oil, natural gas, and geothermal wells. CalGEM's regulatory program emphasizes the wise development of oil, natural gas, and geothermal resources in the state through sound engineering practices that protect the environment, prevent pollution, and ensure public safety.

CEQA (California Public Resources Code, Sections 21000 et seq.) and State CEQA Guidelines Protection for Paleontological Resources

CEQA includes "objects of historic … significance" in its definition of the environment (Public Resources Code Section 21060.5), and Section 15064.5 of the State CEQA Guidelines further defines historic resources as including "any object…site, area, [or] place… that has yielded, or may be likely to yield, information important in prehistory." This has been widely interpreted as extending CEQA consideration to paleontological resources, although neither the statute nor the Guidelines provide explicit direction regarding the treatment of paleontological resources. However, impacts on paleontological resources are addressed in Appendix G of the State CEQA Guidelines as checklist question "f" under Environmental Factor Geology and Soils (Issue VII), which asks whether the proposed project would "Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?"

California Public Resources Code

The California Public Resources Code (Cal. Public Res. Code) also protects paleontological resources in specific contexts. In particular, California Public Resources Code Section 5097.5 prohibits "knowing and willful" excavation, removal, destruction, injury, and defacement of a vertebrate paleontological feature on public lands without express authorization from the agency with jurisdiction. Violation of this prohibition is a misdemeanor and is subject to fine or imprisonment (Cal. Public Res. Code Section 5097.5(c)), and persons convicted of such a violation may also be required to provide restitution (Cal. Public Res. Code Section 5097.5(d)(1)). Additionally, California Public Resources Code Section 30244 requires "reasonable mitigation measures" to address impacts on paleontological resources identified by the State Historic Preservation Officer.

California Administrative Code (California Code of Regulations, Title 14, Sections 4307–4309)

The sections of the California Administrative Code relating to the State Division of Beaches and Parks afford protection to geologic features and "paleontological materials" on lands administered by the division. The code also assigns the director of the state park system the authority to issue permits for activities that may result in damage to such resources, if the activities are for state park purposes and are in the interest of the state park system.

3.9.2.3 Regional and Local

This section discusses relevant regional and local programs, policies, regulations, and permitting requirements. The project section would primarily be within Los Angeles and Orange Counties, and the cities of Los Angeles, Vernon, Commerce, Bell, Montebello, Pico Rivera, Santa Fe Springs, Norwalk, La Mirada, Buena Park, Fullerton, and Anaheim. Table 3.9-1 lists local plans and policies that were identified and considered for geology, soils, and seismicity analysis. Table 3.9-2 lists local plans and policies that were identified and considered for paleontological resources analysis.

Table 3.9-1 Regional and Local Plans and Policies: Geology, Soils, and Seismicity

Policy Title	Summary
Los Angeles County	
Los Angeles County 2035 General Plan, Safety Element, Conservation and Natural Resources Element (2025)	The County of Los Angeles last updated the *Los Angeles County 2035 General Plan* in 2025. The General Plan Safety Element includes the following goal and policies: ▪ Geotechnical Hazards, Goal S 1: An effective regulatory system that prevents or minimizes personal injury, loss of life and property damage due to seismic and geotechnical hazards. – Policy S 1.1: Discourage development in Seismic Hazard and Alquist-Priolo Earthquake Fault Zones. – Policy S 1.2: Prohibit construction of structures for human occupancy adjacent to active faults unless a comprehensive fault study that addresses seismic hazards risks and proposes appropriate actions to minimize the risk is approved. – Policy S 1.3: Require developments to mitigate geotechnical hazards, such as soil instability and landsliding, in Hillside Management Areas through siting and development standards. – Policy S 1.4: Support the retrofitting of unreinforced masonry structures and soft-story buildings to help reduce the risk of structural and human loss due to seismic hazards. The General Plan Conservation and Natural Resources Element includes the following policy: ▪ Policy C/NR 13.8: Manage development in HMAs to protect their natural and scenic character and minimize risks from natural hazards, such as fire, flood, erosion, and landslides.
Los Angeles County Code of Ordinances (2025)	The Los Angeles County Code is codified through Ordinance 205-0029. ▪ Title 26 – Building Code, Appendix J - Grading. Adopted as amended. ▪ Section 119.1: California Building Code: Adopted as amended. ▪ Section 1803.5.11: Requires a soils investigation to assess the potential consequences of any liquefaction and soil strength loss.
City of Los Angeles	
City of Los Angeles General Plan, Safety Element (2024)	The City of Los Angeles last updated the *City of Los Angeles General Plan* in 2024. The Safety Element includes the following policy: ▪ Hazard Mitigation, Policy 1.1.6, State and Federal Regulations: Assure compliance with applicable State and federal planning and development regulations. Regularly adopt new provisions of the California Building Standards Code, Title 24, and California Fire Code into the LAMC to ensure that new development meets or exceeds Statewide minimums. Ensure new development in VHFHSZs adheres to the California Building Code, the California Fire Code, Los Angeles Fire Code and California Public Resources Code. Facilitate compliance with new standards for existing non-conforming structures and evacuation routes.
Los Angeles Municipal Code (2025)	The Los Angeles Municipal Code is current through legislation effective July 4, 2025. ▪ California Building Code – Adopted. The 2013 California Building Code is based on the 2012 International Building Code as published by the International Code Council as adopted and amended by the California Building Standards Commission in the 2013 California Building Standards Code of the 2013 California Code of Regulations title 24, together with all appendices. – Chapters 1 through 96, Los Angeles Building Code. Adopted as amended – Section 106, Permits, Los Angeles Building Code – Title 24, together with all appendices

Policy Title	Summary
City of Vernon	
City of Vernon General Plan, Safety Element (2023)	Vernon adopted the *City of Vernon General Plan* on December 3, 2007, and last amended it in 2023. The general plan includes the following goals and policies in the Safety Element: ▪ Goal S-1: Minimize the risk to public health, safety, and welfare associated with the presence of natural and human-caused hazards. ▪ Goal S-4: Provide a high degree of protection for all workers and residents in the event of any disaster. – Policy S-4.3: Design and maintain an effective plan for the prompt evacuation of the City in the event of a dam inundation or other major disaster requiring the removal of workers or residents from Vernon.
The Code of the City of Vernon (2024)	The Code of the City of Vernon is codified through Ordinance No. 1303, adopted August 6, 2024. ▪ Chapter 15.08.010 California Building Code. Adopted as amended.
City of Montebello	
City of Montebello General Plan, Our Safe Community (2024)	Montebello adopted the *City of Montebello General Plan* on April 10, 2024. The Our Safe Community Element includes the following policies and actions: ▪ P6.7: Identify and appraise the geologic and seismic hazards within the community. Reduce the loss of life, damage to property, and the economic and social dislocations resulting from future earthquakes. – A6.7b: Require all aspects of the earthquake, fault rupture, liquefaction, and related seismic hazard evaluation process (planning, investigation, analysis, reporting, review, construction, and operations) for new development and redevelopment to be conducted and independently reviewed by qualified professionals. – A6.7c: Require new or substantially remodeled development located within areas of liquefaction potential to be properly designed and constructed for to earthquake safety, and require all development (including City-owned facilities) to comply with established seismic safety standards.
City of Montebello Municipal Code (2024)	The City of Montebello Municipal Code is codified through Ordinance No. 2475, passed March 27, 2024. ▪ Chapter 15.04.010 California Building Code. Adopted as amended.
City of Pico Rivera	
City of Pico Rivera General Plan, Safety Element (2014)	Pico Rivera published the amendment to the *City of Pico Rivera General Plan* on September 15, 2014. The general plan includes the following policies: ▪ Policy 9.1-2 Geotechnical Studies: Require that geotechnical studies be prepared for development in areas where geologic or seismic hazards may be present, such as liquefaction in the central portion of the city and in the Whittier Narrows Dam area. ▪ Policy 9.1-3 Infrastructure: Encourage property owners, Caltrans, the railroads, and local utility companies to regularly inspect and strengthen (as needed) infrastructure susceptible to failure during an earthquake.
Pico Rivera Municipal Code (2025)	The Pico Rivera Municipal Code is codified through Ordinance No. 1194, adopted May 13, 2025. ▪ Chapter 15.08.010 California Building Code. Adopted as amended.

Policy Title	Summary
City of Santa Fe Springs	
City of Santa Fe Springs Code of Ordinances (2025)	The City of Santa Fe Springs Code is codified through Ordinance No. 1157, passed January 28, 2016, and last updated February 18, 2025. ▪ Title 15, Section 150.001 California Building Code. Adopted as amended.
City of Norwalk	
Norwalk Municipal Code (2024)	The Norwalk Municipal Code is codified through Ordinance No. 23-1746-12, passed August 18, 2016, and last updated December 5, 2024. ▪ Chapter 15.06.010 California Building Code. Adopted as amended.
City of La Mirada	
City of La Mirada General Plan, Safety and Community Services Element (2003)	La Mirada adopted the *La Mirada General Plan* on March 25, 2003. The general plan includes the following goal and policies: ▪ Goal 1.0: Reduce the risk of danger related to seismic hazards. – Policy 1.1 Review all development proposals in seismically hazardous areas to consider the design and intensity of the proposed use in relation to potential seismic risk. – Policy 1.2 Require geotechnical engineering studies for development proposals on properties identified as subject to liquefaction and landslides.
La Mirada Code of Ordinances (2024)	The La Mirada Code of Ordinances is codified through Ordinance No. 675, passed November 8, 2015, and updated in 2024. ▪ Title 17.04.010 California Building Code. Adopted as amended.
Orange County	
County of Orange General Plan, Safety Element (2025)	The County of Orange adopted the *County of Orange General Plan* in July 2014 and updated it in 2025. The Safety Element includes the following goals and policies: ▪ Natural Hazards Component, Goal 2: Minimize the effects of natural safety hazards through implementation of appropriate regulations and standards which maximize protection of life and property. ▪ Seismic Safety and Geologic Hazards, Policy 5: To encourage establishment of seismic design criteria and standards for county facilities (e.g., transmission lines, water and sewage systems, and highways), any structures housing necessary mobile units and support equipment, and other vital resources which would be needed following an earthquake (e.g., “back-up” power generation facilities and water storage). ▪ Seismic Safety and Geologic Hazards, Policy 8: To establish development standards for land use, new construction, and proposed improvements to ensure proper design and location of structures.
Codified Ordinances of the County of Orange (2024)	The Codified Ordinances of the County of Orange are codified through Ordinance No. 23-005-002, passed March 15, 2016. and last updated in 2024. ▪ Section 7-1-12, California Building Code. Adopted as amended.
Orange County Grading Manual (2017)	The County of Orange updated its grading manual in 2017. This document contains the following information: ▪ Compilation of rules, procedures, and interpretations necessary to carry out provisions of the Orange County Grading Code. The purpose of the Grading Manual is to control excavation, grading, and earthwork construction in unincorporated Orange County.

Policy Title	Summary
City of Buena Park	
City of Buena Park 2035 General Plan, Safety Element (2022)	Buena Park adopted the *City of Buena Park 2035 General Plan* on December 7, 2010, and last updated it in 2022. The Safety Element includes the following goal and policies: ▪ Goal SAF-1: Decrease in the potential risk of seismic and geologic hazards to the community. – Policy SAF-1.1: Seek to avoid or minimize seismic risk by appropriately designating land uses and adhering to current building codes. – Policy SAF-1.2: Enforce the requirements of current building codes relative to seismic design for all new development or redevelopment. – Policy SAF-1.3: Require geologic and soils reports for all new development or redevelopment, especially in identified areas of the Norwalk Fault Zone and areas with high liquefaction potential. – Policy SAF-1.4: Require appropriate mitigation measures and/or conditions of approval relative to terrain, soils, slope stability, and erosion for new development or redevelopment in order to reduce hazards.
Buena Park Municipal Code (2025)	The City of Buena Park Code is codified through Ordinance No. 1730, passed in 1991 and last updated in 2025. ▪ Title 15 Building and Construction Safety. Adopted as amended.
City of Anaheim	
City of Anaheim General Plan, Safety Element (2025)	Anaheim adopted the *City of Anaheim General Plan* on May 25, 2004, and last updated it in 2025. The general plan includes the following goals and policies: ▪ Goal 1.1: A community prepared and responsive to seismic and geologic hazards. – Policy 1: Minimize the risk to public health and safety and disruptions to vital services, economic vitality, and social order resulting from seismic and geologic activities. – Policy 3: Require geologic and geotechnical investigations in areas of potential seismic or geologic hazards as part of the environmental and/or development review process for all structures. – Policy 4: Enforce structural setbacks from faults and other geologic hazards identified during the development review process. – Policy 5: Enforce the requirements of the California Seismic Hazards Mapping and Alquist-Priolo Earthquake Fault Zoning Acts when siting, evaluating, and constructing new projects within the City. – Policy 6: Require that engineered slopes be designed to resist earthquake-induced failure. – Policy 9: Require new construction, redevelopment, and major remodels located within potential landslide areas be evaluated for site stability, including the potential impact to other properties, during project design and review.
Anaheim Municipal Code (2025)	The Anaheim Municipal Code is codified through Ordinance No. 6585, passed July 23, 2024. ▪ Chapter 15.03.0101 California Building Code. Adopted as amended.

Sources: City of Anaheim 2025a, 2025b; City of Buena Park 2022, 2025; City of La Mirada 2003, 2024; City of Los Angeles 2024, 2025; City of Montebello 2024a, 2024b; City of Norwalk 2024; City of Pico Rivera 2014, 2025; City of Santa Fe Springs 2025; City of Vernon 2023, 2024; County of Los Angeles 2025a, 2025b; County of Orange 2017, 2024, 2025

Caltrans = California Department of Transportation; HMA = Hillside Management Area; LAMC = Los Angeles Municipal Code; VHFHSZ = very high fire hazard severity zone

Table 3.9-2 Regional and Local Plans and Policies: Paleontological Resources

Policy Title	Summary
Los Angeles County	
Los Angeles County 2035 General Plan, Conservation and Natural Resources Element (2025)	The County of Los Angeles adopted the *Los Angeles County 2035 General Plan* on October 6, 2015, and last updated it in 2025. The Conservation and Natural Resources Element includes the following policies: ▪ Policy C/NR 14.1: Mitigate all impacts from new development on or adjacent to historic, cultural, and paleontological resources to the greatest extent feasible. ▪ Policy C/NR 14.2: Support an inter-jurisdictional collaborative system that protects and enhances historic, cultural, and paleontological resources. ▪ Policy C/NR 14.5: Promote public awareness of historic, cultural, and paleontological resources. ▪ Policy C/NR 14.6: Ensure proper notification and recovery processes are carried out for development on or near historic, cultural, and paleontological resources.
Los Angeles County Code of Ordinances (2025)	The County of Los Angeles Code is codified through Ordinance 2025-0029. ▪ Title 26 – Building Code, Appendix J - Grading. Adopted as amended.
City of Los Angeles	
City of Los Angeles General Plan, Conservation Element (2024)	The City of Los Angeles last updated the *City of Los Angeles General Plan* in 2024. The Conservation Element includes the following objective and policy: ▪ Archaeological and Paleontological Resources, Objective 1: Protect the City's paleontological resources for historical, cultural, research, and/or educational purposes. ▪ Archaeological and Paleontological Resources, Policy 1: Continue to identify and protect significant paleontological sites and/or resources known to exist or that are identified during land development, demolition, or property modification activities. The Conservation Element of the *City of Los Angeles General Plan* identifies natural and cultural resources within the City and describes objectives, policies, and programs for their protection, preservation, and management. Chapter II: Resource Conservation and Management, Section 3: Archaeological and Paleontological discusses protection of paleontological resources and states, in part: "Pursuant to CEQA, if a land development project is within a potentially significant paleontological area, the developer is required to contact a bona fide paleontologist to arrange for assessment of the potential impact and mitigation of potential disruption of or damage to the site. If significant paleontological resources are uncovered during project execution, authorities are to be notified and the designated paleontologist may order excavations stopped, within reasonable time limits, to enable assessment, removal or protection of the resources." (p. II-5) This section also indicates that the city is responsible for protecting paleontological resources and outlines the following objective, policy, and program regarding paleontological resources (p. II-5, II-6): ▪ Objective: protect the City's archaeological and paleontological resources for historical, cultural, and/or educational purposes. ▪ Policy: continue to identify and protect significant archaeological and paleontological sites and/or resources known to exist or that are identified during land development, demolition or property modification activities. ▪ Program: permit processing, monitoring, enforcement and periodic revision of regulations and procedures.

<table>
<tr><th>Policy Title</th><th>Summary</th></tr>
<tr><td>Los Angeles Municipal Code (2025)</td><td>The Los Angeles Municipal Code is codified through changes effective July 4, 2025.
▪ Chapters 1 through 96 Los Angeles Building Code. Adopted as amended.
▪ Section 106, Permits, Los Angeles Building Code.</td></tr>
<tr><td colspan="2">City of Vernon</td></tr>
<tr><td>The Code of the City of Vernon (2024)</td><td>The Code of the City of Vernon is codified through Ordinance No. 1300, adopted May 7, 2024.
▪ Chapter 15.08.010 California Building Code. Adopted as amended.</td></tr>
<tr><td colspan="2">City of Montebello</td></tr>
<tr><td>Montebello Municipal Code (2024)</td><td>The Montebello Municipal Code is codified through Ordinance No. 2475, passed March 27, 2024.
▪ Chapter 15.04.010 California Building Code. Adopted as amended.</td></tr>
<tr><td colspan="2">City of Pico Rivera</td></tr>
<tr><td>City of Pico Rivera General Plan, Environmental Resource Element (2014)</td><td>The City of Pico Rivera adopted the City of Pico Rivera General Plan in 2014. The general plan includes the following goals and policies in the Environmental Resource Element:
▪ Goal 8.7 Preservation of important cultural and paleontological resources that contribute to the unique identity and character of Pico Rivera.
– Policy 8.7-1 Resource Preservation: Protect and preserve significant historic, archaeological, and paleontological resources, including those recognized at the national, state, and local levels.
– Policy 8.7-3 Consultation: As part of the development review process, ensure that potential impacts to historic, archaeological, and paleontological resources are minimized.
– Policy 8.7-4 Resource Assessment: Require new development necessitating discretionary approval that could potentially impact historic, archaeological, and/or paleontological resources to conduct a resource survey to ensure that potential sites are identified for avoidance or special treatment.</td></tr>
<tr><td>Pico Rivera Municipal Code (2025)</td><td>The Pico Rivera Municipal Code is codified through Ordinance No. 1194, adopted May 13, 2025.
▪ Chapter 15.08.010 California Building Code. Adopted as amended.</td></tr>
<tr><td colspan="2">City of Santa Fe Springs</td></tr>
<tr><td>City of Santa Fe Springs Code of Ordinances (2025)</td><td>Title 15, Section 150.001: California Building Code</td></tr>
<tr><td colspan="2">City of Norwalk</td></tr>
<tr><td>Norwalk Municipal Code (2024)</td><td>The Norwalk Municipal Code is codified through Ordinance No. 23-1746-12, passed August 18, 2016, and last updated December 5, 2024.
▪ Chapter 15.06.010 California Building Code. Adopted as amended.</td></tr>
<tr><td colspan="2">City of La Mirada</td></tr>
<tr><td>La Mirada Municipal Code (2024)</td><td>Chapter 17.04.010: California Building Code</td></tr>
</table>

Policy Title	Summary
Orange County	
County of Orange General Plan, Resources Element (2025)	The County of Orange adopted the *County of Orange General Plan* in 2014 and updated it in 2025. The general plan includes the following goals and policies in the Resources Element: ▪ Cultural-Historic Resources, Goal 1: To raise the awareness and appreciation of Orange County's cultural and historic heritage. ▪ Cultural-Historic Resources, Goal 2.2: Take all reasonable and proper steps to achieve the preservation of archaeological and paleontological remains, or their recovery and analysis to preserve cultural, scientific, and educational values. ▪ Paleontological Resources, Policy 1: To identify paleontological resources through literature and records research and surface surveys. ▪ Paleontological Resources, Policy 2: To monitor and salvage paleontological resources during the grading of a project. ▪ Paleontological Resources, Policy 3: To preserve paleontological resources by maintaining them in an undisturbed condition.
Codified Ordinances of the County of Orange (2024)	Section 7-1-12: California Building Code
Orange County Grading Manual (2017)	Compilation of rules, procedures, and interpretations necessary to carry out provisions of the Orange County Grading Code. The purpose of the grading manual is to control excavation, grading, and earthwork construction in unincorporated Orange County.
City of Buena Park	
Buena Park 2035 General Plan, Conservation and Sustainability Element (2022)	Buena Park last updated the *Buena Park 2035 General Plan* in 2022. The general plan includes the following goal and policy: ▪ Goal CS-3: Protection of important archaeological and paleontological resources. – Policy CS-3.1: Preserve and protect significant archaeological and paleontological resources.
Buena Park Municipal Code (2025)	The Buena Park Municipal Code is codified through Ordinance No. 1730, last updated in 2025. ▪ Title 15 Building and Construction Safety. Adopted as amended.
City of Anaheim	
Anaheim Municipal Code (2025)	Chapter 15.03.0101: California Building Code

Sources: City of Anaheim 2025b; City of Buena Park 2022, 2025; City of La Mirada 2024; City of Los Angeles 2024, 2025; City of Montebello 2024b; City of Norwalk 2024; City of Pico Rivera 2014, 2025; City of Santa Fe Springs 2025; City of Vernon 2024; County of Los Angeles 2025a, 2025b; County of Orange 2017, 2024, 2025

3.9.3 Consistency with Plans and Laws

As indicated in Section 3.1.5.3, Consistency with Plans and Laws, CEQA and NEPA require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws. CEQA and FRA NEPA implementing procedures require the discussion of any inconsistency or conflict between a proposed action and federal, state, regional, or local plans and laws. Where inconsistencies or conflicts exist, the California High-Speed Rail Authority (Authority) must provide a description of the extent of reconciliation and the reason for proceeding if full reconciliation is not feasible under NEPA (64 *Federal Register* 28545, 14(n)(15)) and must discuss the inconsistencies between the proposed project and applicable general plans, specific plans, and regional plans under CEQA (State CEQA Guidelines Section 15125(d)).

Several federal and state laws, listed in Section 3.9.2.1, Federal, and Section 3.9.2.2, State, pertain to GSSPR. The Authority, as the lead state agency proposing to build and operate the HSR system, is required to comply with federal and state laws and regulations and to secure applicable federal and state permits prior to initiating construction of the project. Pursuant to 23 U.S.C. 327, under the NEPA Memorandum of Understanding between the FRA and the State of California, effective July 22, 2024, the Authority is the federal lead agency for environmental reviews and approvals for all Authority Phase 1 and Phase 2 California HSR System projects. Therefore, there would be no inconsistencies between the Shared Passenger Track Alternatives and these federal and state laws and regulations.

The Authority is a state agency and is therefore not required to comply with local land use and zoning regulations; however, it has endeavored to design and build the HSR project so that it is consistent with land use and zoning regulations. The Shared Passenger Track Alternatives would be consistent with all regional and local policies related to GSSPR, but would be inconsistent with the following local policy:

- County of Orange General Plan (2025): Resources Element, Policy 3, To preserve paleontological resources by maintaining them in an undisturbed condition

As discussed further in Section 3.9.6, Environmental Consequences (Impact GSSPR-11), the project elements, station sites, and maintenance facility are underlain by geologic units that are sensitive for paleontological resources. The project includes **GEO-IAMF#11, Engage a Qualified Paleontological Resources Specialist**, through **GEO-IAMF#15**, **Halt Construction, Evaluate, and Treat if Paleontological Resources Are Found**, that serve to identify and preserve yet undiscovered resources. However, the project would be inconsistent with this policy because it has potential to disturb paleontological resources. Treatment would be curation rather than nondisturbance (refer to Impact GSSPR-11).

The Authority's approach to managing impacts on paleontological resources is consistent with the Society of Vertebrate Paleontology's (SVP) best practices (SVP 2010), which recommends

1. An intensive field survey and surface salvage
2. Monitoring by a qualified paleontological resource monitor of excavations in previously undisturbed rock units
3. Salvage of unearthed fossil remains and traces
4. Screen washing to recover small specimens
5. Preparation of salvaged fossils to a point of being ready for curation
6. Identification, cataloging, curation, and provision for repository storage of prepared fossil specimens
7. A final report of finds and their significance

The SVP recommendations consider curation, storage, and a final report to be adequate mitigation for disturbance of paleontological resources.

Refer to Appendix 3.1-A, Regional and Local Policy Inventory and Consistency Analysis, for a complete consistency analysis of local plans and policies.

3.9.4 Methods for Evaluating Impacts

The evaluation of impacts on GSSPR is a requirement of NEPA and CEQA. The following sections define the RSA and summarize the methods used to analyze impacts on GSSPR. As summarized in Section 3.9.1, Introduction, several other sections provide additional information related to GSSPR.

3.9.4.1 Definition of Resource Study Areas

As defined in Section 3.1, Introduction, RSAs are the geographic boundaries in which the Authority conducted environmental investigations specific to each resource topic. The boundaries of the RSA for resource topics included in GSSPR extend beyond the project footprint and also extend into the subsurface beneath the project footprint. The RSA for geology, soils, and seismicity effects, and for paleontological resources effects is defined slightly differently for each resource group. The basis for defining the types of GSSPR RSAs, and the differences between them, are explained further in the sections below. Table 3.9-3 provides a general definition and boundary description for each RSA within the project section as depicted on Figure 3.9-1.

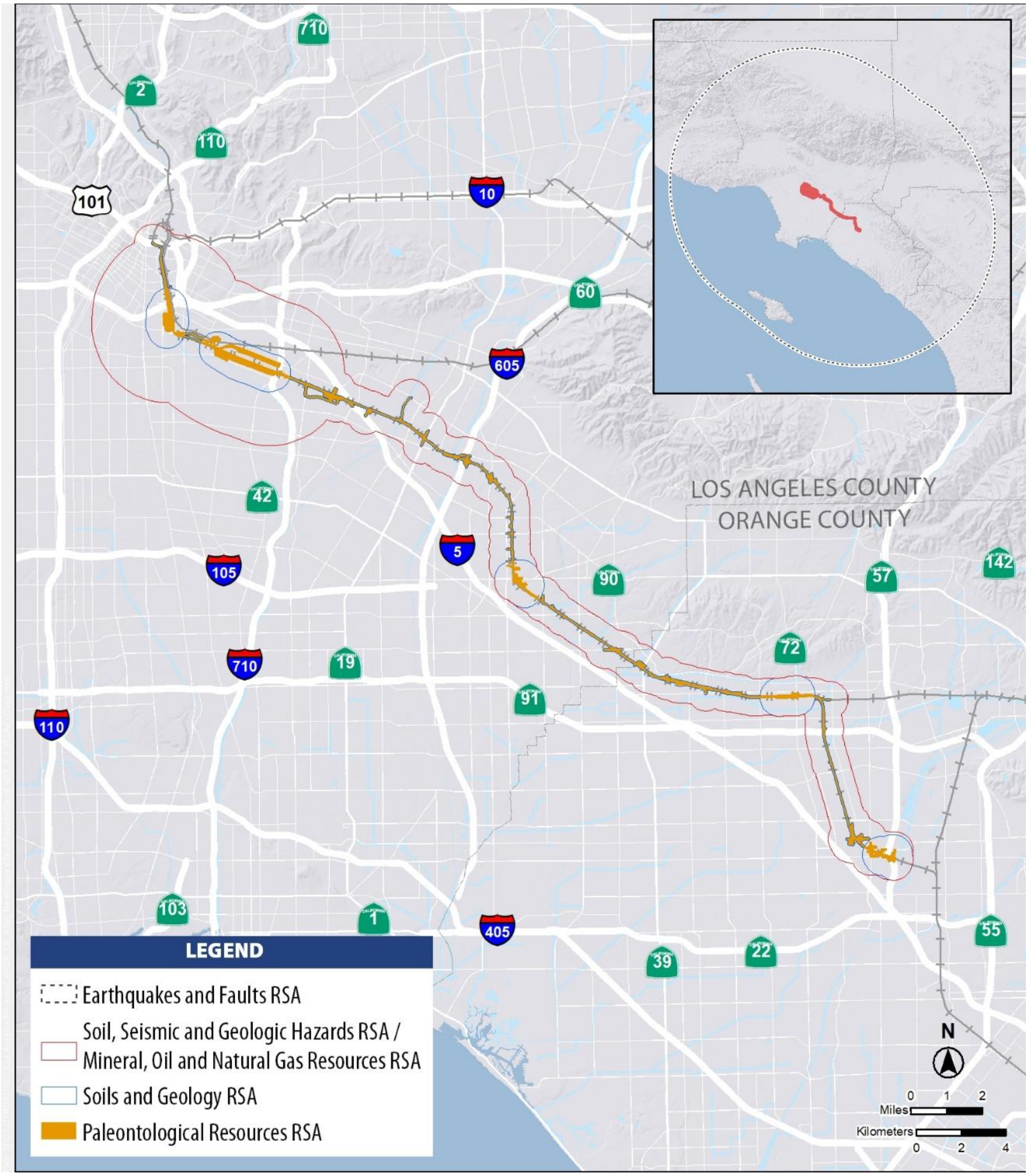
Table 3.9-3 Definition of Geology, Soils, Seismicity, and Paleontological Resources Resource Study Area

General Definition	Resource Study Area Boundary
Geology, Soils, and Seismicity	
General geology, soils, geologic hazards, and secondary seismic-related hazards except dam inundation	Project footprint plus a 150-foot buffer around surface and elevated portions of the project footprint and a 200-foot buffer for the cut-and-cover section of the project footprint and the project footprint plus a 0.5-mile radius around each station site and maintenance facility.[1] The RSA expands to the project footprint plus a 0.5-mile radius for soil failures, settlement, corrosivity, shrink-swell, erosion, earthquake-induced liquefaction, and subsidence.
Resource hazards, such as subsurface gas hazards, mineral resource extraction, fossil fuel resources, and geothermal resources	Project footprint plus 0.5-mile buffer around at-grade portions of the project footprint, with a 2-mile buffer around maintenance sites and station sites.
Seismicity, including primary seismic hazards and dam inundation	Project footprint plus a 50-mile buffer around project footprint.[1]
Paleontology	
Paleontological resources	Project footprint plus a 150-foot buffer around the project footprint. The RSA also extends subsurface below the project footprint to include geological units below the horizontal RSA that project construction or operation may encounter.

[1] The project footprint includes all areas required to build, operate, and maintain all permanent high-speed rail facilities, including permanent right-of-way, permanent utility and access easements, and temporary construction easements.
RSA = resource study area

The size of the general geology, soils, and seismicity RSA captures local effects such as areas of difficult excavation. The size of the resource hazards RSA captures hazards that may not have strictly local effects, such as subsidence and subsurface gas hazards. The earthquake and faults RSA extends past the most seismically active area eastward and westward, into the ocean to the west and into the Central Valley eastward, thus capturing historically active faults (USGS and CGS 2023). North and south, the earthquake faults and dams RSA captures historically active faults in the area other than the San Andreas, which extends from Mexico in the south to offshore in northern California. Furthermore, this RSA captures dams that would potentially inundate the HSR.

The RSA for paleontological resources is defined as the project footprint plus a 150-foot buffer plus the vertical dimension to include all geologic units below the horizontal RSA that project construction or operation may encounter. The depth of the vertical dimension will vary regionally based primarily on project construction techniques.



Source: ESRI 2020

Figure 3.9-1 Geology, Soils, Seismicity, and Paleontological Resources Resource Study Area

3.9.4.2 Impact Avoidance and Minimization Features

The Shared Passenger Track Alternatives incorporate standardized HSR features to avoid and address impacts. These features are referred to as IAMFs and are considered part of the project. The Authority will incorporate IAMFs during project design and construction; therefore, the analysis of impacts of the Shared Passenger Track Alternatives in this section factors in all applicable IAMFs. Appendix 2-A provides a detailed description of IAMFs that are included as part of the project. The IAMFs differ from mitigation measures in that they are part of the project regardless of whether an impact is identified in this document. In contrast, mitigation measures may be available to further reduce, compensate for, or offset project impacts that the analysis identifies under NEPA or concludes are significant under CEQA. IAMFs applicable to GSSPR include:

- **GEO-IAMF#1: Geologic Hazards**. The contractor will prepare a Construction Management Plan (CMP) that addresses geological and geotechnical constraints and resources. At a minimum it will address the following geologic constraints resources (**GEO-IAMF#1A** through **GEO-IAMF#1F**).
  - **GEO-IAMF#1A: Groundwater Withdrawal**. The Authority-designated contractor will apply controls for the amount of groundwater withdrawal from the project, by reinjecting groundwater, or using alternate foundation designs to offset potential for settlement.
  - **GEO-IAMF#1B: Unstable Soils**. The contractor will employ various methods to mitigate for the risk of ground failure, such as replacement with competent soils, strengthening with geosynthetics, stone columns and similar approaches, and vertical drains.
  - **GEO-IAMF#1C: Subsidence.** The Authority-designated contractor will establish survey monuments and monitoring for subsidence.
  - **GEO-IAMF#1D: Wind and Water Erosion**. The Authority-designated contractor will implement erosion control methods as appropriate from the various erosion control methods documented in the Construction Stormwater Pollution Prevention Plan (refer to **HYD-IAMF#3, Prepare and Implement Construction Stormwater Pollution Prevention Plan**), the California Department of Transportation (Caltrans) Construction Manuals, and the construction technical memorandum, and in coordination with other erosion, sediment, stormwater management, and fugitive dust control efforts.
  - **GEO-IAMF#1E: Soils with Shrink-Swell Potential.** The Authority-designated contractor will require removing or treating the soil in areas where shrink-swell potential is unacceptable.
  - **GEO-IAMF#1F: Soils with Corrosive Potential.** The Authority-designated contractor will require removing soils in areas where soils have potential to be corrosive to steel or concrete, designing buried structures for corrosive conditions, and using corrosive-protected materials in infrastructure.
- **GEO-IAMF#2: Slope Monitoring.** The Authority will require monitoring of slopes during operations and maintenance at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading.
- **GEO-IAMF#3: Gas Monitoring.** The Authority-designated contractor will prepare a CMP addressing how gas monitoring will be incorporated into construction BMPs.
- **GEO-IAMF#6: Ground Rupture Early Warning Systems.** The Authority-designated contractor will document how the project design incorporates installation of early warning systems, triggered by strong ground motion association with ground rupture. Known nearby active faults would be monitored.
- **GEO-IAMF#7: Evaluate and Design for Large Seismic Ground Shaking.** The Authority-designated contractor will prepare a technical memorandum documenting how temporary construction and permanent HSR components were evaluated and designed for large seismic ground shaking in relation to the most recent version of the Caltrans seismic design criteria or the equivalent thereof.
- **GEO-IAMF#8: Suspension of Operations During an Earthquake.** The Authority-designated contractor will prepare a technical memorandum documenting how suspension of operations during or after an earthquake was addressed in project design.
- **GEO-IAMF#9: Subsidence Monitoring.** The Authority will develop and implement a stringent track-monitoring program that will monitor the effects of ongoing subsidence, to provide early warning of reduced track integrity.

- **GEO-IAMF#10: Geology and Soils.** The Authority-designated contractor will prepare a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction.
- **GEO-IAMF#11: Engage a Qualified Paleontological Resources Specialist.** The Authority-designated contractor will retain a paleontological resources specialist (PRS) responsible for reviewing the construction package (CP) and developing the Paleontological Resources Monitoring and Mitigation Plan (PRMMP) for the CP.
- **GEO-IAMF#12: Perform Final Design Review and Triggers Evaluation.** The responsible PRS will evaluate the 90 percent design submittal for each CP within the project section to identify the portions of the CP that would involve work in paleontologically sensitive geologic units, in consideration of the final *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b). The purpose would be to develop specific language detailing the paleontological monitoring and other requirements applicable to each CP within the project section.
- **GEO-IAMF#13: Prepare and Implement a Paleontological Resource Monitoring and Mitigation Plan**. The PRS will develop a CP-specific PRMMP incorporating the Final Design Review and triggering evaluation for each CP.
- **GEO-IAMF#14: Provide Worker Environmental Awareness Program (WEAP) Training for Paleontological Resources**. The Authority-designated contractor will deliver a paleontological resources WEAP training delivered by the PRS to management and supervisory personnel and construction workers involved with ground-disturbing activities before beginning work on the project.
- **GEO-IAMF#15: Halt Construction, Evaluate, and Treat if Paleontological Resources Are Found**. The Authority will require activity to cease, consistent with the PRMMP, in the immediate vicinity of known or potential fossil materials discovered during construction in order to protect the find from further disturbance.

Other resource IAMFs applicable to impacts on GSSPR include:

- **HYD-IAMF#3:** Prepare and Implement Construction Stormwater Pollution Prevention Plan
- **SS-IAMF#3:** Hazard Analyses
- **SS-IAMF#4:** Oil and Gas Wells

In Section 3.9.6, each impact narrative describes how these project features are applicable and, where appropriate, effective at avoiding or minimizing potential impacts to less-than-significant levels under CEQA.

3.9.4.3 Methods for Impact Analysis

This section describes the sources and methods the Authority used to analyze the impacts of implementing the Shared Passenger Track Alternatives on geology, soils, and paleontological resources, and seismicity. These methods apply to both NEPA and CEQA analyses unless otherwise indicated. Refer to Section 3.1.5.4, Methods for Evaluating Impacts, for a description of the general framework for evaluating impacts under NEPA and CEQA. Laws, regulations, and local planning documents (refer to Section 3.9.2, Laws, Regulations, and Orders) that regulate geology, soils, seismicity, and paleontological resources were also considered in the evaluation of direct and indirect impacts on geology, soils, and paleontological resources, and from seismicity. For project construction and operational actions that would result in impacts, feasible mitigation measures are identified to avoid or minimize impacts or to compensate for impacts.

The following sections discuss methods to evaluate direct and indirect impacts on GSSPR.

Geology, Soils, and Seismicity

The following methods were used to evaluate impacts the Shared Passenger Track Alternatives could have on geology and soils, including seismicity:

- Reviewed U.S. Geological Survey and CGS landslide inventories and data available from other published sources, including county water districts and local water agencies, to evaluate the potential for landslides and subsidence resulting from construction activities.
- Overlaid the geographic information system (GIS) layer for the Shared Passenger Track Alternatives over Natural Resources Conservation Service (NRCS) soils survey data to determine impacts from expansive, erodible, collapsible, or corrosive soils.
- Evaluated primary seismic hazards by overlaying GIS layers for the Shared Passenger Track Alternatives on the GIS layers for Quaternary age faults as delineated by the U.S. Geological Survey and CGS. Only active faults within 50 miles of the Shared Passenger Track Alternatives were considered. Direct primary seismic effects evaluated included surface fault ruptures, permanent offsets at the ground surface, and ground shaking.
- Evaluated secondary seismic hazards from strong ground shaking, including liquefaction, seismically induced slides or slumps, and flooding resulting from seismically induced dam failure. The same methods were used as described for primary seismic hazards (overlaying GIS layers), using CGS hydrogeologic map set data to identify areas of shallow groundwater and Holocene-age alluvial deposits that have been delineated as potentially liquefiable and used data available from the California Office of Emergency Services for dam failure inundation pathways along the RSA. The relevant CGS seismic hazard reports and maps were used, which include the maps depicting zones of liquefaction potential and earthquake-induced landslides.
- Performed a qualitative analysis for effects related to areas with fossil fuel and geothermal resources. A combination of oil field maps, CGS mineral resource maps, and CalGEM geothermal maps were overlaid over the Shared Passenger Track Alternatives to identify fossil fuel and geothermal resources in the area along the project section.

Paleontological Resources

Professional Standards and Authority's Environmental Methodology Guidelines

Although federal and state regulations establish protection for paleontological resources, the legal framework is nonspecific regarding some critical details:

- What resources merit protection?
- What constitutes a significant adverse effect on those resources?
- What level of protection is adequate?

This gap has been filled in two ways: through processes and protocols developed by individual practitioners and professional societies and through guidelines developed by federal, state, and local lead agencies under NEPA and CEQA, respectively.

To comply with applicable laws such as the American Antiquities Act of 1906, Paleontological Resources Preservation Act, California Public Resources Code Section 5097.5, and California Code of Regulations, Title 14, Sections 4307–4309, the SVP, a scientific organization of professional vertebrate paleontologists, has established standard guidelines (SVP 1996, 2010) that outline acceptable professional practices in the conduct of paleontological resource assessments and surveys, monitoring and mitigation, data and fossil recovery, sampling procedures, museum curation, and specimen preparation, identification, and analysis. The SVP's standard guidelines were approved by a consensus of professional paleontologists and are the standard against which many paleontological monitoring and mitigation programs are judged. Most professional paleontologists in California adhere closely to the SVP's assessment, mitigation, and monitoring requirements as specifically spelled out in these standard guidelines. Many regulatory agencies as well as many county and city agencies have either formally or informally adopted the SVP's standard guidelines for the mitigation of construction-related adverse impacts on paleontological resources. In addition, the SVP (2010) standard guidelines are in accordance with the specific reporting and monitoring requirements set forth in the Caltrans *Standard Environmental Reference* (Caltrans 2025). Briefly, SVP guidelines provide guidance for assessing the likelihood that geologic units contain significant fossils, require literature and museum archival reviews for each project, as well as a field survey, and, if there is a high potential for disturbing significant fossils during project construction, a mitigation plan that includes monitoring by a qualified paleontologist to salvage fossils encountered, identify salvaged fossils and determine their significance, and place curated fossil specimens into a permanent paleontological repository (e.g., public museum or other institution with a permanent curator on staff).

The portion of the *Environmental Methodology Guidelines*, Version 5.11 (Authority 2022) that addresses paleontological resources was based largely on the methodology laid out in Chapter 8, Paleontology, of the Caltrans *Standard Environmental Reference* (Caltrans 2025). The Caltrans methodology is an appropriate model for Authority needs because it is not only consistent with the discipline-standard SVP Standard Guidelines/Standard Procedures but was also developed to meet Caltrans' responsibilities under both NEPA and CEQA. The key difference between the Caltrans approach and the Authority's *Environmental Methodology Guidelines* is that the latter replaced Caltrans' multiple sequential technical reports with a single project-specific technical report that meets the requirements of both the Caltrans Paleontological Identification Report and Paleontological Evaluation Report outlines. This approach streamlines the technical report preparation process without loss of scientific substance.

Assessment of Paleontological Significance

The primary concern related to impacts on paleontological resources is the potential for loss of scientific information, and particularly new information. This means it is important to distinguish resources that are scientifically important—meaning significant—from those that have a lower potential to provide information.

Significant paleontological resources are those that provide taxonomic, taphonomic, phylogenetic, stratigraphic, ecologic, or climatic information. *Taxonomic* refers to the classification of things, specifically organisms. *Taphonomic* refers to the branch of paleontology that deals with the processes of fossilization. *Phylogenetic* relates to the evolutionary development and diversification of a species or group of organisms or particular feature of an organism. *Stratigraphic* refers to the branch of geology dealing with the classification, nomenclature, correlation, and interpretation of stratified rocks. *Ecologic* is characterized by the interdependence of living organisms in an environment and *climactic* relates to climate. Significant fossils may include body fossils (the remains of the organism itself), as well as traces, tracks, and trackways (which record the presence and movement of past organisms in their environment). In California, vertebrate fossils of all types and sizes are considered significant because of their comparative rarity and their informational potential. Invertebrate fossils, plant fossils, and microfossils may also be scientifically important and therefore significant. This definition reflects the prevailing discipline standards for paleontological resources, as described in both the Caltrans approach (Caltrans 2025) and guidance from the SVP (SVP 1996, 2010).

The paleontological resources impact analysis involved the following four steps:

1. Identify the geologic units in the RSA, including both surface-exposed geologic units and those in the subsurface that may be encountered by excavation, tunneling, foundation drilling, or other activity.
2. Evaluate the potential of the identified geologic units to contain significant fossils (their *paleontological potential* or *paleontological sensitivity*).
3. Identify/assess the nature and extent of impacts from project construction and operation. All ground-disturbing project activities are to be considered including but not necessarily limited to site preparation, excavation, grading, tunneling, and foundation drilling.

4. Evaluate impact effects or significance.

The following section presents additional information on the steps in the process.

Paleontological Resource Inventory

The Authority completed a resource inventory and evaluation process through the following activities:

- Compilation of geologic mapping for the project section vicinity in GIS software
- Identification of geologic units within the RSA by overlaying the RSA boundary and anticipated maximum depth of disturbance on the compiled geologic map
- Compilation of information on lithology and fossil content of affected units
- Evaluation of paleontological sensitivity based on fossil content

To maximize detail, resource evaluation focused on available 1:24,000-scale mapping; larger-scale mapping evaluations provided additional context. The *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b) provides complete reference information for the maps used.

Numerous sources provided information on the currently known fossil content of the affected units, including the published geologic and paleontological literature, university and museum databases, and relevant theses and dissertations, as discussed in more detail in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

Table 3.9-4 presents the paleontological potential/sensitivity categories used in this analysis to identify the potential for geologic units to yield significant fossils—that is, their paleontological sensitivity.

Table 3.9-4 Paleontological Potential/Sensitivity Categories Used in this Analysis

Paleontological Sensitivity Rating	Description
High potential (high sensitivity)	Includes rock units that, based on previous studies, are known or likely to contain significant vertebrate, invertebrate, or plant fossils, including but not limited to sedimentary formations that contain significant nonrenewable paleontological resources anywhere within their geographical extent, and sedimentary rock units temporally or lithologically suitable for the preservation of fossils. May include some volcanic and low-grade metamorphic rock units. Fossiliferous deposits with very limited geographic extent or an uncommon origin (e.g., tar pits and caves) are given special consideration. *High sensitivity* reflects the potential to contain (1) abundant vertebrate fossils; or (2) a few significant vertebrate, invertebrate, or plant fossils that may provide new and significant taxonomic, phylogenetic, ecologic, and stratigraphic data. It also encompasses areas that may contain datable organic remains older than the Recent geological period (5,000 years BP), including packrat or woodrat (*Neotoma* sp.) middens and areas that may contain unique new vertebrate deposits, traces, and trackways.
Low potential (low sensitivity)	Includes sedimentary rock units that (1) are potentially fossiliferous but have not yielded significant fossils in the past; (2) have not yielded fossils but have the potential to do so; or (3) contain common or widespread invertebrate fossils whose taxonomy, phylogeny, and ecology are well understood. Sedimentary rocks expected to contain vertebrate fossils are not placed in this category because vertebrate fossils are typically rare and occur in more localized deposits.
No potential (not sensitive)	Includes rock units considered to have no potential to contain significant paleontological resources, such as rocks of intrusive igneous origin, most volcanic rocks, and moderate- to high-grade metamorphic rocks.

Source: Authority 2025b

BP = before present

3.9.4.4 Methods for Evaluating Impacts Under NEPA

NEPA implementing procedures, regulations, and guidance provide the basis for evaluating project effects (as described in Section 3.1.1.). The criteria of context and intensity are considered together when determining the severity of changes introduced by the project:

- **Context:** For this analysis, the *context* includes the type, quality, and sensitivity of the resource involved, the location, or the geographical extent of the effect (national, regional, or local). For the analysis of geology, soils, and seismicity, the context includes the proximity to geologic, soil, and seismic hazards of concern, such as active faults and mapped landslide areas; the relative risk levels (i.e., low, moderate, high) of these hazards in proximity to the project; and the potential for occurrence of energy and mineral resources. For the analysis of paleontological resources, conditions—including the likelihood that fossils would be encountered within the project ground-disturbance area and the potential for geologic units to contain scientifically important fossil resources—were considered.[2] In addition, the relevant paleontological resources regulatory setting was considered.
- **Intensity:** For this analysis, *intensity* is determined by the potential duration of exposure to geologic, soil, and seismic hazards (e.g., during excavation activity, duration of project operations); the potential for geologic, soil, and seismic hazards to occur during construction and operations (e.g., frequency of large earthquakes); the degree or severity to which the project could affect public safety and property associated with geologic, soil, and seismic hazards; and the volume of mineral or energy resources that would be unavailable for extraction or number and size of mineral operations that would have restricted access. To inform the severity of effects, the analysis focuses on direct impacts in comparison to No Project effects. The intensity or severity of an effect on paleontological resources is determined by assessing the potential for physical disturbance associated with the project to result in the loss or destruction of significant scientific information found in paleontological resources.

3.9.4.5 Methods for Determining Significance Under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (State CEQA Guidelines Section 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a threshold-based impact analysis. Under CEQA, significant impacts are determined by evaluating whether project impacts would exceed the significance threshold established for the resource (Section 3.1.5.4). The Authority is using the following thresholds to determine if a significant impact on geology, soils, and paleontological resources as well as from seismic activity would occur as a result of the Shared Passenger Track Alternatives.

Geology, Soils, and Seismicity

For this analysis, the project would result in a significant impact related to geology, soils, and seismicity if it would:

- Directly or indirectly cause substantial adverse effects, including the risk of loss of life, injuries, or destruction beyond what people are exposed to currently in the area's environment caused by seismic activity or its related hazards, including surface fault rupture,[3]

---

[2] Important fossil resources are fossils that provide taxonomic, phylo-genetic, ecologic, and stratigraphic and geochronologic data; body fossils, casts and impressions, trace fossils, and tracks and trackways; and vertebrate fossils.

[3] Refer to the most recent Alquist-Priolo Earthquake Fault Zoning map issued by the State Geologist for the area or other substantial known evidence of known faults to identify known faults in the RSA. Refer to Division of Mines and Geology Special Publication 42.

strong ground shaking, ground failure including liquefaction, dam failure, seiche or tsunami, and landslides

- Result in substantial soil erosion or the loss of topsoil in a large area that adversely affects the viability of the ecosystem or productivity of farming present in the area
- Render currently stable geologic units or soil unstable to a degree that it would result in increased exposure of people to loss of life or structures to destruction caused by geologic hazards, such as primary and secondary seismic hazards
- Be built on expansive soil or corrosive soils as defined in Table 18-1-B of the Uniform Building Code (1994, or most recent applicable Uniform Building Code, International Building Code, or California Building Standards Code) that result in an increased exposure of people to loss of life or structures to destruction as a result of the soils' nature, for instance causing the collapse of the structure
- Make a known petroleum or natural gas resource of regional or statewide value unavailable to extraction through the physical presence of the project either at the ground surface or subsurface
- Result in the loss of availability of a locally important mineral resource recovery site
- Be in an area of subsurface gas hazard, including landfill gas, and one that would provide a route of exposure to that hazard that results in a substantial risk of loss of life or destruction of property

The risk to the project from existing geological hazards is not considered an impact under CEQA and is therefore not further evaluated in this EIR/EIS. The risk of exposing people or property to existing geologic, soil, and seismic hazards is discussed in the *Los Angeles to Anaheim Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2025a). Incorporation of IAMFs will reduce existing risks associated with geologic, soil, and seismic hazards during construction and operation (Authority 2025a).

Paleontological Resources

For this analysis, the project would result in a significant impact on paleontological resources if it would directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

3.9.5 Affected Environment

This section describes the affected environment for GSSPR in the RSAs, including soil hazards, geological hazards, primary seismic hazards, secondary seismic hazards, area of difficult evacuation, and mineral resources. This information provides the context for the environmental analysis and evaluation of impacts.

A summary of stakeholder issues and concerns from public outreach efforts can be found in Chapter 9, Public and Agency Involvement.

Analysis for geologic units in the project section is divided into three portions that differ from those in other resource analyses: the Northern, Central, and Southern Portions. Soils are discussed by county, including Los Angeles and Orange Counties. Other resources are discussed regionally. Paleontologically sensitive materials are exposed at the surface in the paleontological resources RSA, including the project footprint plus a 150-foot buffer around the project footprint.

3.9.5.1 Geology, Soils, and Seismicity

Physiography and Regional Geologic Setting

The Shared Passenger Track Alternatives would traverse a portion of the Los Angeles Basin, a structural trough filled with sedimentary formations that are overlain by near-surface alluvial deposits. The Los Angeles Basin is within the northern portion of the Peninsular Ranges geomorphic province of California, one of the 11 geomorphic provinces in California, each with distinct and unique landforms, topographic relief, climate, and geology (Harden 2004). This physiographic basin is bounded on the north by the San Gabriel Mountains of the Transverse Ranges geomorphic province; on the south and east by the San Joaquin Hills and Santa Ana Mountains of the Peninsular Ranges geomorphic provinces, respectively; and on the west by the Pacific Ocean (Yerkes et al. 1965).

The RSA is along a gently sloping, northwest to southeast-trending alluvial plain of low topographic relief referred to as the Central Plain (Yerkes et al. 1965) or the Coastal Plain (Poland et al. 1959). The Central Plain slopes gently southward from near the southern margins of the Elysian, Puente, Coyote, and Peralta Hills. Review of the Los Angeles, Southgate, Whittier, La Habra, Anaheim, and Orange, California 7.5-Minute series quadrangle topographic maps (photo revised 1981), indicates that surface water locally sheet flows toward the southwest to various drainage channels and thence to the Pacific Ocean.

The RSA crosses several southerly flowing river channels and drainages, including the Los Angeles River, Rio Hondo River, San Gabriel River, Coyote Creek (North), La Mirada Creek, Coyote Creek (South), Brea Creek, Fullerton Creek, and Carbon Creek. These water courses originate in higher topographic areas to the northwest and northeast of the project section. Existing ground surface elevations along the RSA range from a topographic high of approximately 280 feet above mean sea level at Los Angeles Union Station to approximately 100 feet above mean sea level south of the Norwalk/Santa Fe Springs HSR platform and station facilities area.

Geologic Units

The RSA traverses surficial geologic units that range from Pleistocene to Holocene age (1.8 million years to 11,000 years or younger). The surficial geologic units are predominantly alluvial deposits that were derived from erosion of hillside terrain along the margins of the Los Angeles Basin. The alluvial sediments were subsequently transported down-gradient by gravity, sheet flow, and concentrated runoff, and deposited in alluvial fan, floodplain, and channel wash environments. The geologic map units along the RSA are depicted on Figure 3.9-2 (sheets 1 through 3).

Northern Portion

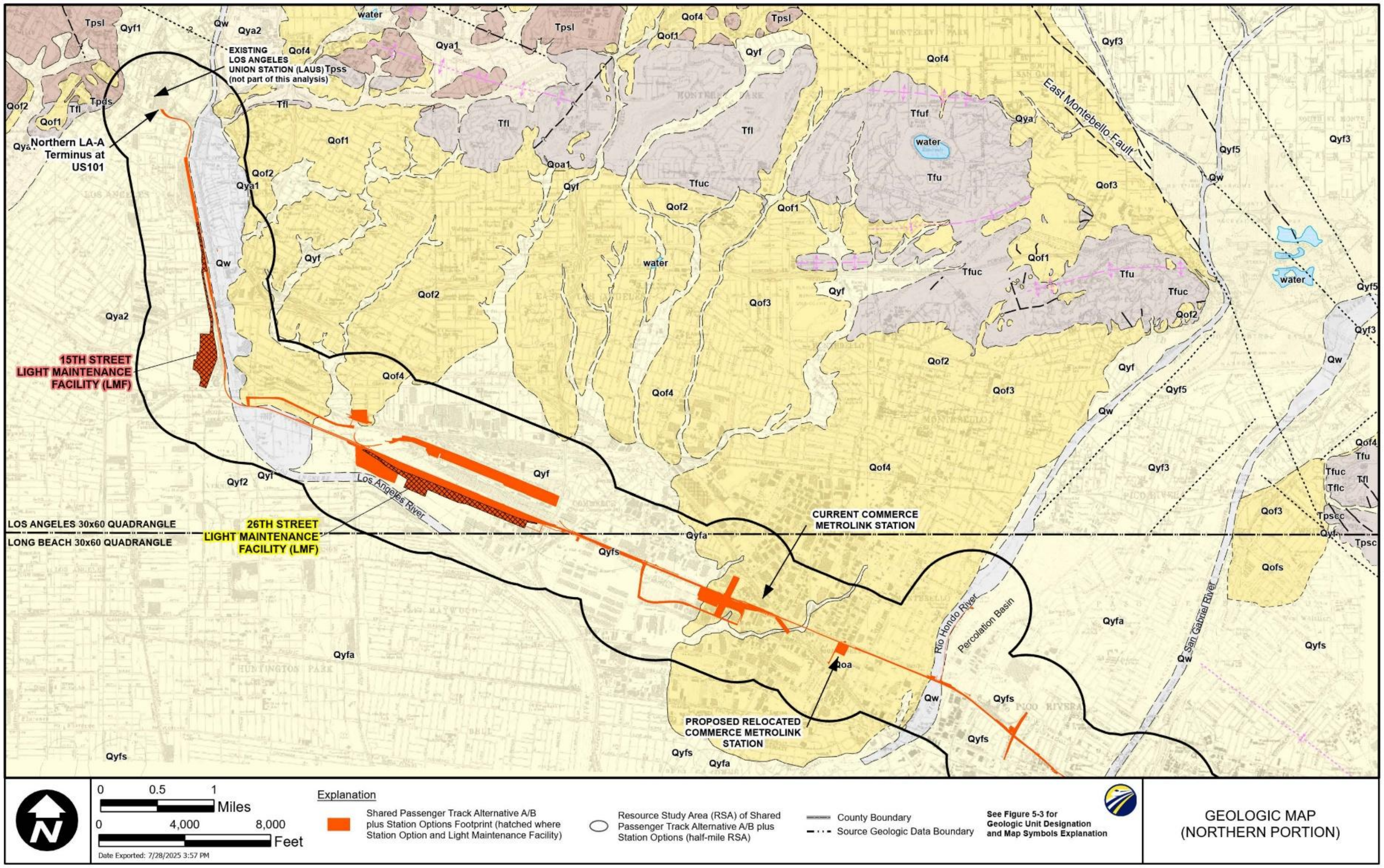
The northern portion of the RSA is underlain by Pleistocene to Holocene-age alluvial fan deposits (geologic map symbols: Q_{of} and Q_{yf}), some alluvial filled channel wash deposits, and floodplain deposits. These deposits have been partly modified by historical cut-and-fill grading associated with urbanization of the Los Angeles Basin. Holocene alluvial deposits (Q_{yf}) underlying the northern portion range from generally unconsolidated sand, silt, and variable quantities of gravels, cobbles, and rare boulders. Pleistocene alluvial deposits (Q_{of}) consist of poorly to moderately consolidated sand, silt, and gravels. The younger wash deposits (Q_w) generally consist of sandy alluvium with cobbles and potential boulders in the active channels. The Rio Hondo, Los Angeles River, and San Gabriel River systems consist chiefly of unconsolidated gravels, sands, and silts within active riverbeds and spreading basins.

Central Portion

The central portion of the RSA from the San Gabriel River to the Los Angeles/Orange County boundary line is underlain primarily by gently sloping Pleistocene alluvial fan deposits (Q_{of} and Q_{vof}) that are incised by relatively wide Holocene alluvial drainages (Q_{yf}). The project section also crosses some younger alluvial wash deposits associated with former creek areas. Unmapped and undocumented artificial fill materials are anticipated to underlie portions of the central portion. Holocene alluvial deposits underlying the central portion consist of generally unconsolidated sand, silt, and some clay, with variable gravels and some cobbles. Pleistocene alluvial deposits consist of poorly to moderately consolidated sand, silt, and gravels.

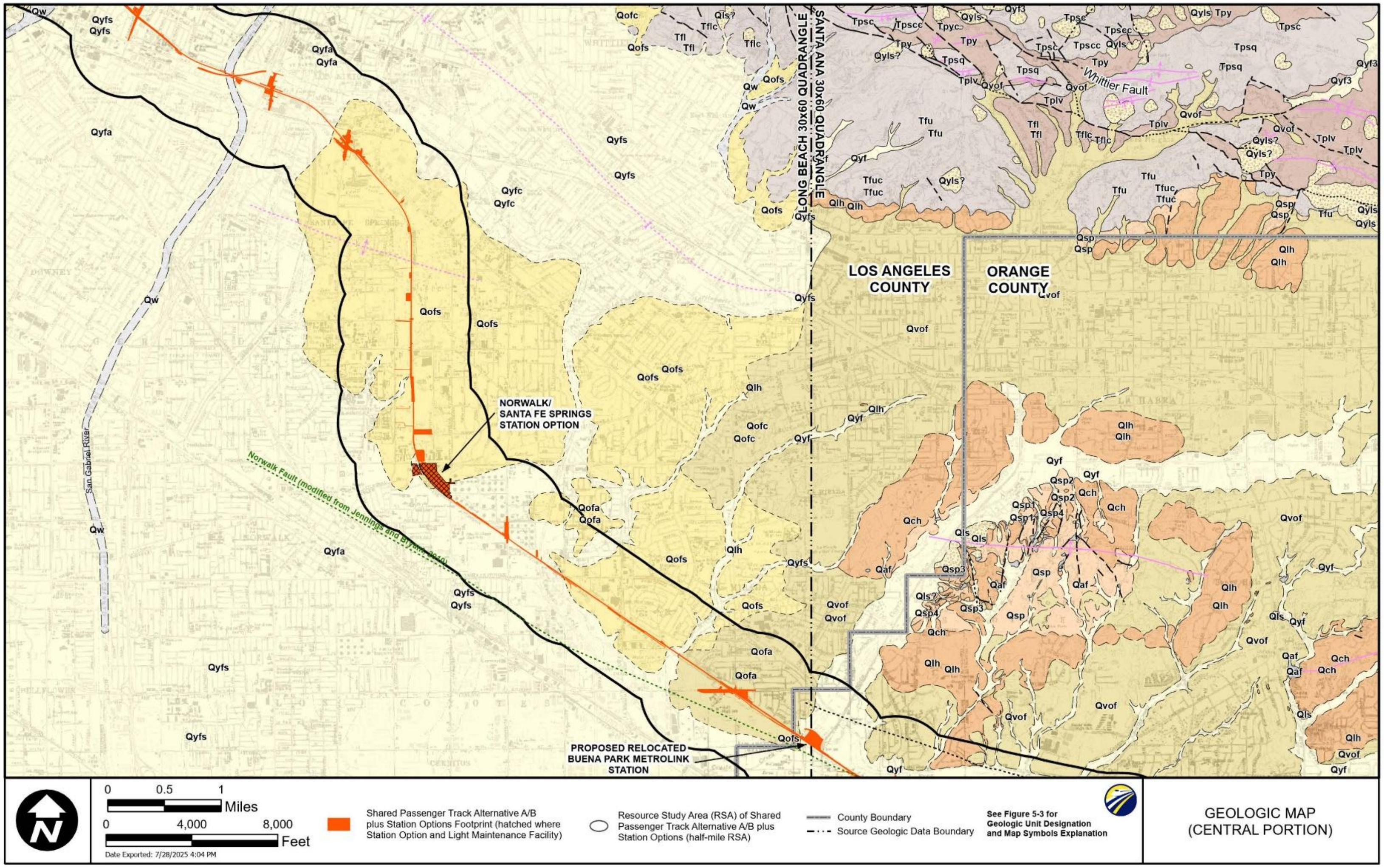
Southern Portion

The southern portion of the RSA from the Orange County boundary line to the terminus at Anaheim Regional Transportation Intermodal Center (ARTIC) is underlain primarily by Holocene alluvial fan and floodplain deposits. Similar to the northern and central portions, unmapped and undocumented artificial fill materials are anticipated to underlie portions of the southern portion. Holocene alluvial deposits underlying the southern portion consist of generally unconsolidated sand, silt, and clay, with some gravel and cobbles.



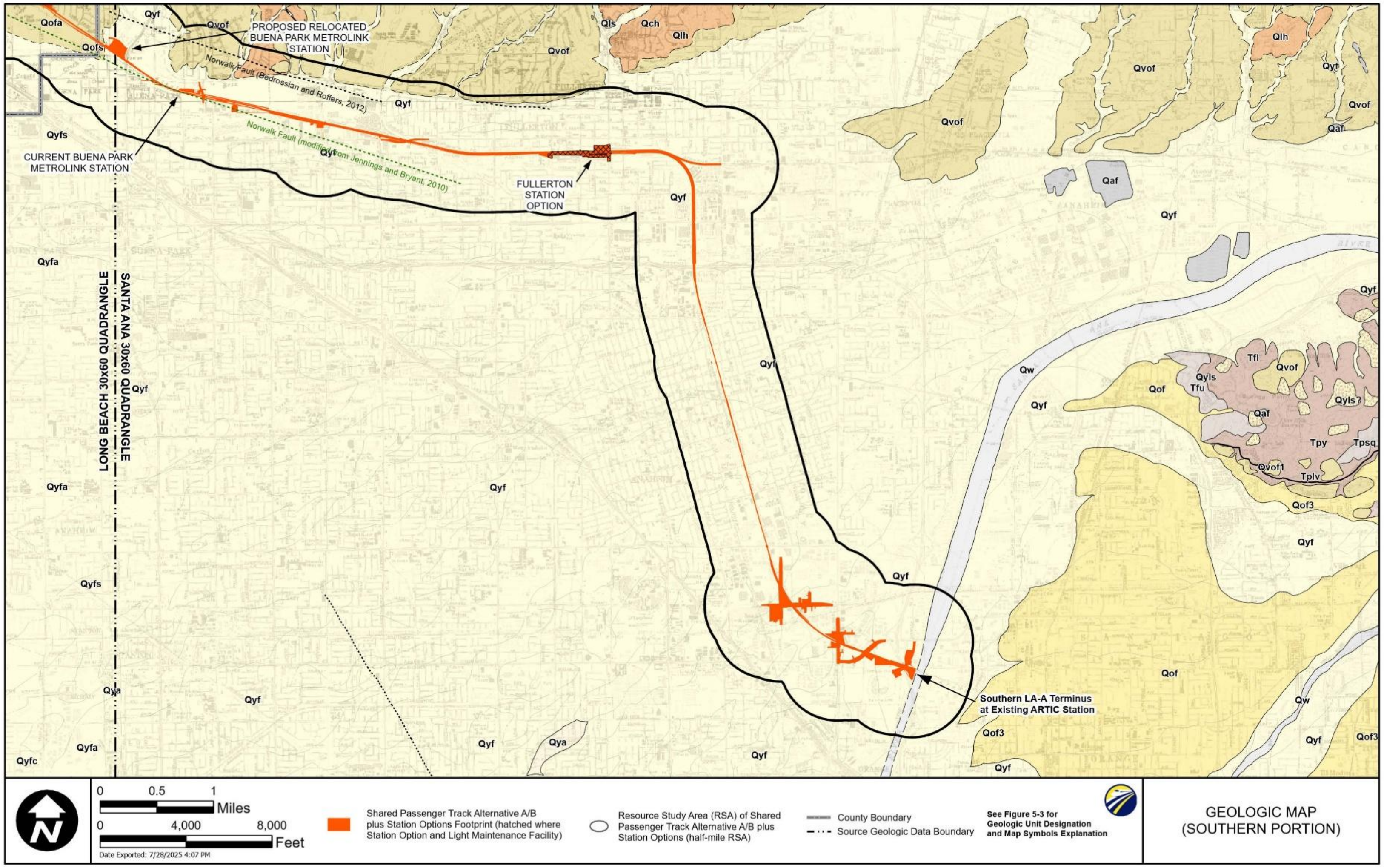
Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; Morton et al. 1999; Saucedo et al. 2003

Figure 3.9-2 Geology of the Resource Study Area, Northern Portion, Sheet 1 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; Morton et al. 1999; Saucedo et al. 2003

Figure 3.9-2 Geology of the Resource Study Area, Central Portion, Sheet 2 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; Morton et al. 1999; Saucedo et al. 2003

Figure 3.9-2 Geology of the Resource Study Area, Southern Portion, Sheet 3 of 3

Soils

NRCS soil surveys describe soil associations within the resource hazards RSA. Soils in two areas of the RSA have been mapped for the Los Angeles County portion and the Orange County portion. Because the soil mapping was done at different times, the methods followed were distinct and the data cannot be combined into one coherent set. However, soil properties can be analyzed and compared across the dataset.

Ten soil map units are identified in the Los Angeles County portion of the RSA. In addition, the NRCS has delineated four areas as being composed of 90 to 95 percent urban lands. These areas, classified by the NRCS as urban lands, are covered with impervious materials such as asphalt and concrete and do not have soil descriptions associated with their respective map units. Each of the soil complexes identified in Los Angeles County contains varying percentages of urban land components.

The soils along the RSA in Los Angeles County have formed on Pleistocene to Holocene-age sedimentary deposits including alluvial fans, fan remnants, alluvial plains, floodplains, and coastal plains. According to NRCS data, soil horizons along the project section include fine sand, fine sandy loam, loamy sand, loam, silt loam, and clay loam (soil terminology per the U.S. Department of Agriculture classification scheme). In addition, horizons of stratified sand, very cobbly sand, and gravelly sand have been identified in river channel areas.

The RSA in Orange County would cross seven soil map units, five of which are typical soil associations, and two of which are river or wash channels. The soils along the project section in Orange County have formed on Pleistocene to Holocene-age sedimentary deposits associated with alluvial processes. The typical soil associations include fine sandy loam, loamy sand, silt loam, sandy clay loam, and silty, clay loam (NRCS 2016). In addition, stratified coarse sand to sandy loam has been identified in river channel areas. Table 3.9-5 and Figure 3.9-3 depict soil associations in the RSA.

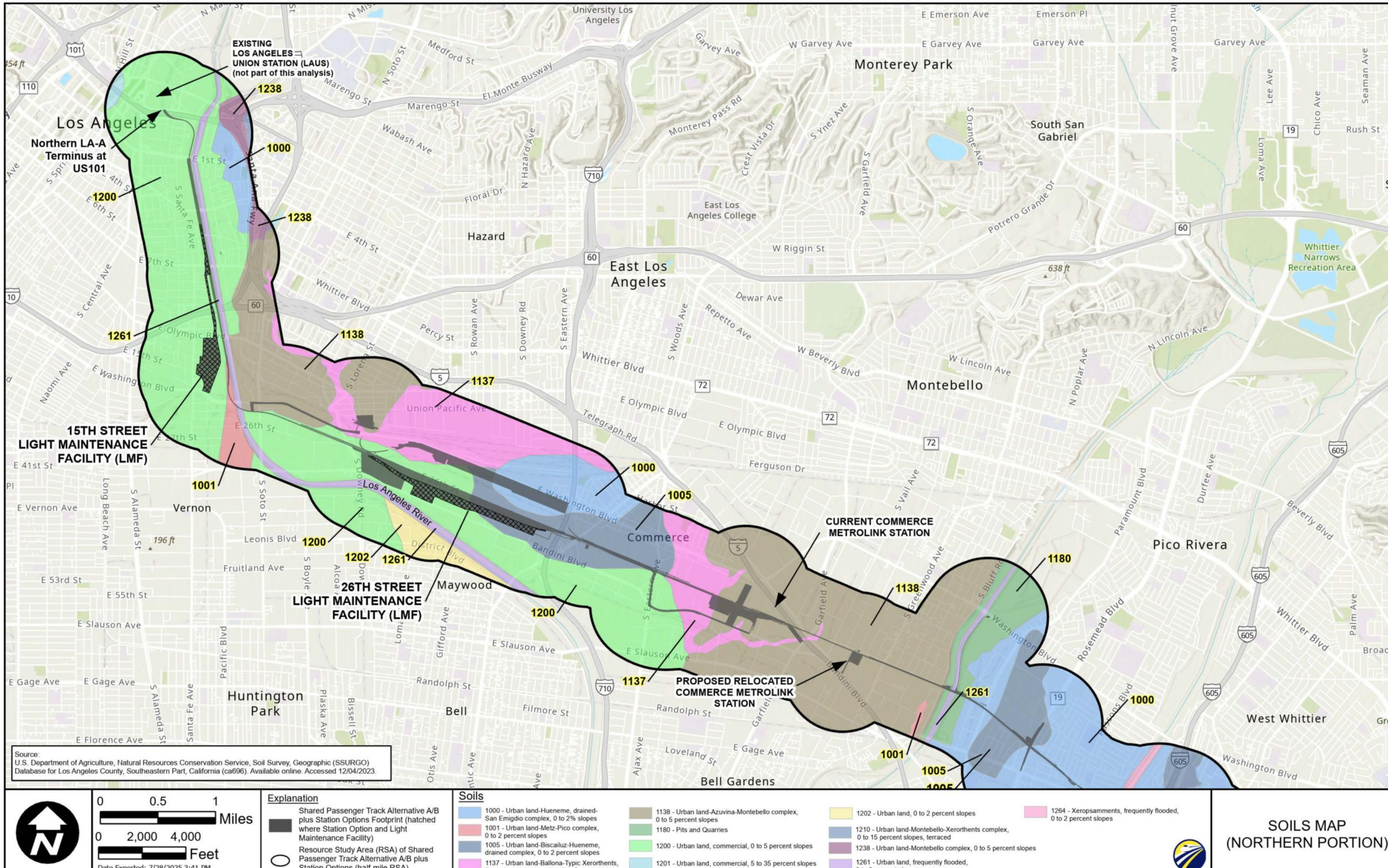
Table 3.9-5 Summary of Soil Hazards by City in the Resource Study Area

City	NRCS Soil Map Units[1]	Potential Soil Property Hazards Based on NRCS Data				
		Collapsible Soils[2]	Corrosive Soils Uncoated Steel[3]	Corrosive Soils Concrete[3]	Expansion Potential: Estimated Relative Range[4]	Erodible Soils
Los Angeles	1000, 1001, 1138, 1200, 1238, 1261	Low to moderate	Low to high	Low to moderate	Low to high	Low to high
Vernon	1001, 1005, 1137, 1200, 1202, 1261	Low to moderate	Low to high	Low	Low to high	Low to high
Bell	1005, 1137, 1200	Low to moderate	Low to high	Low	Moderate to high	Low to high
Commerce	1000, 1005, 1137, 1138, 1200	Low to moderate	Low to high	Low	Low to high	Low to high
Montebello	1001, 1138	Low	Low to high	Low	Low to high	Low to high
Pico Rivera	1000, 1005, 1180, 1261, 1264	Low to moderate	Low to high	Low	Low to high	Low to high
West Whittier–Los Nietos Census Designated Place	1000, 1005	Low to moderate	Low to moderate	Low	Moderate to high	Low to high
Santa Fe Springs	1000, 1005, 1134, 1137, 1261	Low to moderate	Low to high	Low	Low to high	Low to high
Norwalk	1000, 1134	Low to moderate	Low to moderate	Low	Low to high	Low to high
La Mirada	1010, 1134, 1137, 1261	Low to moderate	Moderate to high	Low	Moderate to high	Low to high
Buena Park	140, 164, 173, 177, 196, 217, 218, 219	Low to moderate	Moderate to high	Low to moderate	Low to high	Low to high
Fullerton	163, 164, 166, 173, 175, 177, 194, 218, 219	Low to moderate	Moderate to high	Low to moderate	Low to high	Low to high
Anaheim	158, 163, 164, 191, 194, 196	Low to moderate	Moderate to high	Low to moderate	Low to high	Low to high

[1] Soil units mapped within city along RSA by NRCS; Soil unit name designation from NRCS below:
[2] Collapsible soil potential estimated from surficial geologic units within RSA as depicted on CGS/USGS maps
[3] Corrosion potential from NRCS data considering all soil units in RSA within city
[4] Expansion potential estimated using correlation between expansion potential and Atterberg limit data from NRCS

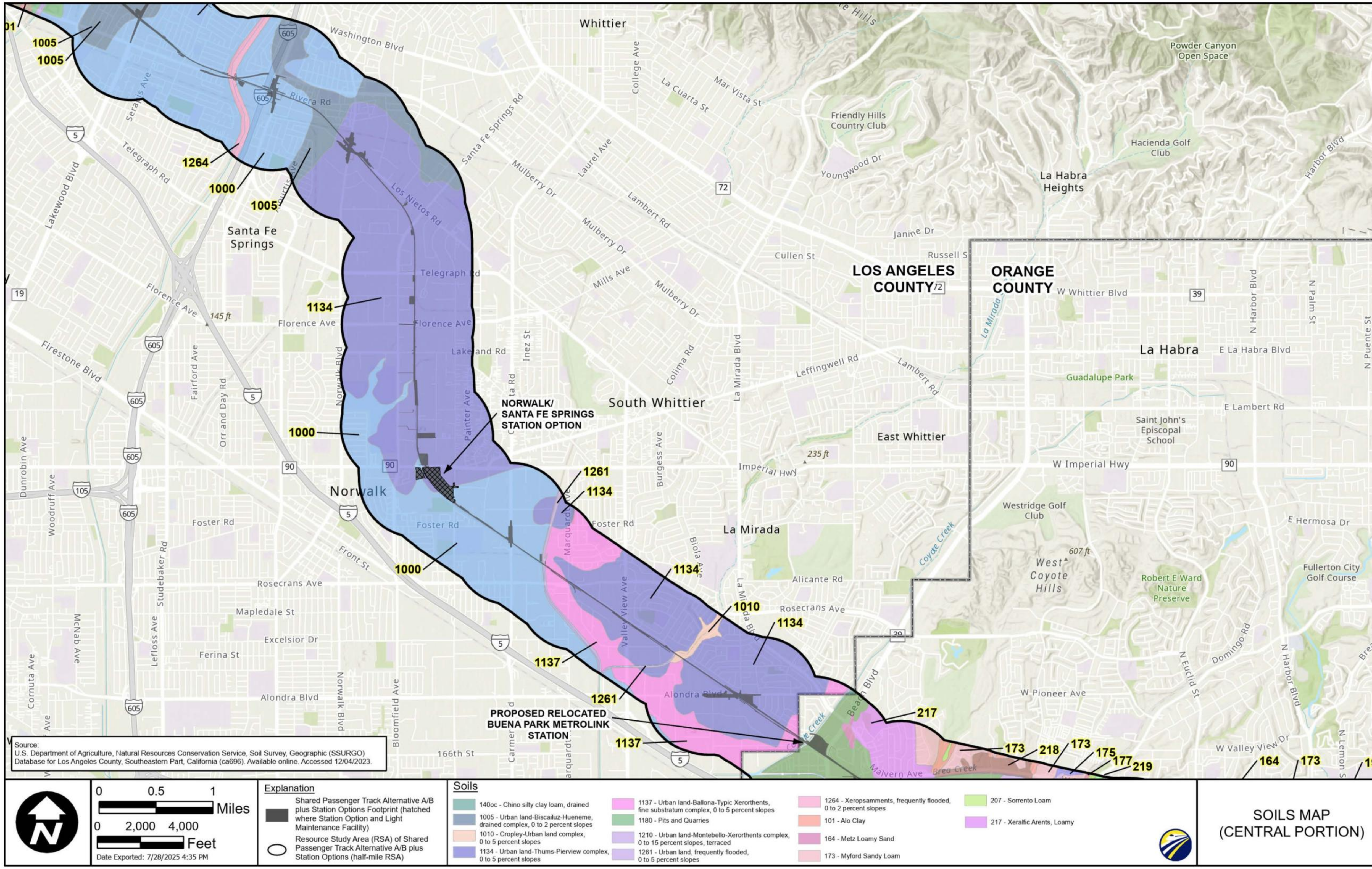
Los Angeles County Soils
1000 - Urban land-Hueneme, drained-San Emigdio complex, 0 to 2 percent slopes
1001 - Urban land-Metz-Pico complex, 0 to 2 percent slopes
1005 - Urban land-Biscailuz-Hueneme, drained complex, 0 to 2 percent slopes
1010 - Cropley-Urban land complex, 0 to 5 percent slopes
1134 - Urban land-Thums-Pierview complex, 0 to 5 percent slopes
1137 - Urban land-Ballona-Typic Xerorthents, fine substratum complex, 0 to 5 percent slopes
1138 - Urban land-Azuvina-Montebello complex, 0 to 5 percent slopes
1180 - Pits and Quarries
1200 - Urban land, commercial, 0 to 5 percent slopes
1201 - Urban land, commercial, 5 to 35 percent slopes
1202 - Urban land, 0 to 2 percent slopes
1210 – Urban land-Montebello-Xerothents complex, 0 to 15 percent slopes, terraced
1238 - Urban land-Montebello complex, 0 to 5 percent slopes
1242 - Urban land-Dapplegray-Soper complex, 20 to 55 percent slopes
1261 - Urban land, frequently flooded, 0 to 5 percent slopes
1264 - Xeropsamments, frequently flooded, 0 to 2 percent slopes

Orange County Soils
101 - Alo Clay, 15 to 30 percent slopes
140 - Chino silty clay loam, drained
158 - Hueneme fine sandy loam, drained
163 - Metz loamy sand
164 - Metz loamy sand, moderately fine substratum
166 - Mocho loam, 0 to 2 percent slopes
175 – Myford sandy loam, 9 to 15 percent slopes
177 – Myford sandy loam, 9 to 30 percent slopes, eroded
178 – Myford sandy loam, this surface, 0 to 2 percent slopes
191 - Riverwash
194 - San Emigdio fine sandy loam, 0 to 2 percent slopes
196 - San Emigdio fine sandy loam, moderately fine substratum, 0 to 2 percent slopes
207 - Sorrento loam, 2 to 9 percent slopes
217 - Xeralfic arents, loamy, 2 to 9 percent slopes
219 – Xerothents loamy, cut-and-fill areas, 9 to 15 percent slopes
CGS = California Geological Survey
NRCS = Natural Resources Conservation Service
RSA = resource study area
USGS = United States Geological Survey



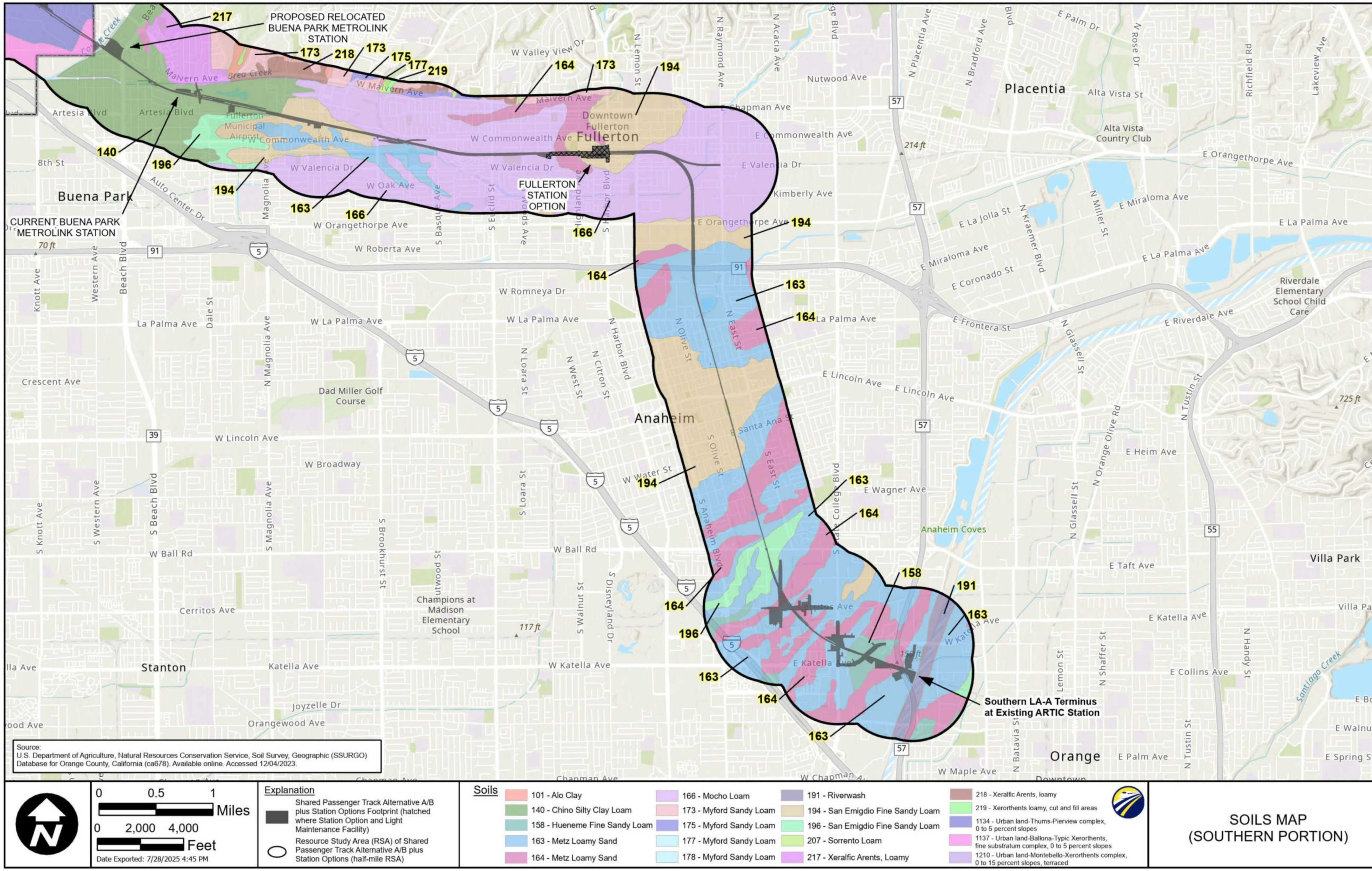
Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; NRCS 2017

Figure 3.9-3 Soils Map, Los Angeles County (Northern Portion), Sheet 1 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; NRCS 2016, 2017

Figure 3.9-3 Soils Map, Los Angeles County (Central Portion), Sheet 2 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; NRCS 2016, 2017

Figure 3.9-3 Soils Map, Orange County (Southern Portion), Sheet 3 of 3

Certain physical and chemical properties of soils may have a negative effect on engineered facilities depending on the soil property characteristics. These property characteristics are presented below.

Expansive Soils

Expansive soils shrink and swell significantly as they lose and gain moisture. The resulting volumetric changes can heave and crack lightly loaded foundations and structures. Soils are generally classified as having low, moderate, and high expansive potentials, where the mineralogical composition and percentage of clay particles present in the soil are indicative of the soil’s expansion potential. Predominantly fine-grained soils containing a high percentage of clays are potentially expansive, whereas predominantly coarse-grained soils such as sands and gravels are generally nonexpansive.

Expansive soils as defined by NRCS (2023) are generally classified as having low, moderate, and high expansive potentials, where the type and percentage of clay particles present in the soil are indicative of the soil’s expansion potential. These classification values qualitatively correspond with the expansive soil values defined by the California Building Standards Code.

Based on boring data from prior borings near the project area (within 1,000 feet of the project footprint) and data accessed from the NRCS website, clayey soils are present along portions of the project section. Consequently, moderately to highly expansive soils could be locally encountered along portions of the project section.

Erodible Soils

Erosion is the detachment and transportation of soil materials by wind or water. Rainfall and potential surface runoff may produce different types of erosion. Potentially erosive conditions are identified as areas having a combination of potentially erosive soils and uncovered slopes. Soil erodibility depends on many factors, including grain size, organic matter content, structure, permeability, and percentage of rock fragments.

Based on NRCS survey information, soils along the project section in Orange County have predominantly low to moderate erodibility with some localized highly erodible soils. Soils along the project section in Los Angeles County are primarily of moderate erodibility with some localized highly erodible soils.

Soil Corrosivity

Soil corrosivity involves the measure of the potential of corrosion for steel and concrete caused by contact with some types of soil. Knowledge of potential soil corrosivity is often critical for the effective design parameters associated with cathodic protection of buried steel and concrete mix design for plain or reinforced concrete buried project elements. Factors—including soil composition, soil and pore water chemistry, moisture content, and pH—affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, high sulfates, and high dissolved salt content are most corrosive.

Soil complexes present along the project section in Los Angeles County are primarily low to moderately corrosive to uncoated steel and low corrosive with respect to concrete. Exceptions to these categories are the Metz-Pico soil complex and Ballona-Typic Xerorthents, which contains soil horizons that are highly corrosive to uncoated steel, and the Montebello soil complex, which contains soil horizons that are moderately to highly corrosive to concrete (per NRCS soil data). NRCS soil survey data for Orange County indicate that the soil associations present along the project section are primarily high to moderately corrosive to uncoated steel and moderately to low corrosive with respect to concrete.

Collapsible Soils

Collapsible soils are soils that undergo settlement on wetting, even without the application of additional load. These soils are characterized by low density and low moisture contents. The soil grains in collapsible soils are not packed tightly together. Although these soils are strong in a dry state, the introduction of water causes the binding agents between grains to quickly break, soften, disperse, or dissolve. The soil grains then shift and shear against each other to re-orient into a denser configuration. This relatively rapid densification of the soil causes a net volume loss of the soil deposit, which is manifested at the ground surface as subsidence or settlement.

Based on limited boring data from historical borings that were drilled within approximately 1,000 feet of the project footprint, there are areas along the project section that are underlain by soils with relatively low density and low moisture content.[4] Therefore, these soils may have a moderate collapse potential.

Geologic Hazards

A geologic hazard area is defined as an area that poses a potential threat to the health and safety of citizens if developed with incompatible commercial, residential, or industrial uses. Two broad categories of geologic hazards exist: seismic and nonseismic. The following sections address the types of nonseismic hazards that could be considerations for the project.

Landslide Hazards

Landslides may occur in areas of generally moderate to steep topography (e.g., commonly, slopes greater than 4:1 horizontal to vertical) where a combination of soil, rock, and groundwater conditions results in ground movement. Landslides can be initiated by soil saturation, earthquakes, volcanic activity, changes in groundwater, disturbance, change of a slope by construction activities, or a combination of these factors.

The RSA would not cross mapped landslide boundaries based on published geologic maps. The nearest mapped landslide relative to the RSA is about 2 miles north of the project section in the Coyote Hills near the city boundaries of La Mirada and La Habra. The topography within and adjacent to the RSA is relatively flat to very gently sloping with only localized areas of steep slopes adjacent to the Los Angeles, Rio Hondo, and San Gabriel River crossings. The river channels have either concrete-lined channel walls or riprap-lined slope protection. Therefore, potential geologic hazards for landslides and mass movements to occur along the project section is considered unlikely.

Land Subsidence

Land subsidence is a form of ground settlement that usually results from changes in fluid content within soil or rock. The volume change can result from localized dewatering of peat, organic soils, or soft silts and clay. Ongoing decomposition of organic-rich soils may also result in land subsidence. This type of subsidence generally occurs in localized areas. The nearest known area of mapped peat deposits is about 500 feet southwest of the footprint and within the larger RSA in the northwestern portion of Buena Park.

A second type of land subsidence is from a regional withdrawal of groundwater, petroleum, or geothermal resources from sedimentary source rocks, which can cause the collapse of the pore space previously occupied by the removed fluid. The compaction of subsurface sediment caused by fluid withdrawal can cause subsidence of the ground surface overlying a pumped reservoir or well. If the volume of water or petroleum removed is sufficiently great, the amount of resulting subsidence may suffice to cause damage to nearby engineered structures. Petroleum extraction was a cause of subsidence in several oil fields in the Los Angeles Basin from the early 1900s into the late 1950s. The RSA would cross three separate oil fields in the cities of Los Angeles, Commerce, and Santa Fe Springs. The Santa Fe Springs oil field is the largest of the three in terms of petroleum extraction volume, number of wells, and oil field dimensions, and was one of several in the Los Angeles Basin where well-defined subsidence has been reported (Castle and Yerkes 1976). In this oil field, a maximum differential subsidence of 0.66 meter (approximately

[4] Important fossil resources are fossils that provide taxonomic, phylo-genetic, ecologic, and stratigraphic and geochronologic data; body fossils, casts and impressions, trace fossils, and tracks and trackways; and vertebrate fossils.

2.2 feet) was measured between 1926 and 1963 in a 16-square-kilometer area (Castle and Yerkes 1976). This is not considered substantial in relationship to the area. Secondary oil recovery through water injection began in the late 1950s in the Los Angeles Basin oil fields and was reported to have greatly reduced or halted the prior subsidence.

Subsidence from changes in groundwater conditions in the Orange County Groundwater Basin is reported to be variable and does not indicate a pattern of widespread irreversible permanent lowering of the ground surface (Woodside and Westropp 2015). Storage conditions in the groundwater basin were at historical lows in the late 1950s, but since that time the Orange County Water District has operated the groundwater basin within a storage range above the historical low.

Information collected from satellites and data collected by the Orange County Surveyor indicate that ground surface elevations in Orange County both rise and fall in response to groundwater recharge and withdrawals (Woodside and Westropp 2015). The data from 1993–1999 indicate temporary seasonal land surface changes of up to 4.3 inches (total seasonal amplitude from high to low) in the Los Angeles and Orange County area and a net decline of approximately 0.5 inch per year near Santa Ana between 1993 and 1999, which happened to coincide with a period of net withdrawal of groundwater from the basin (Bawden et al. 2001, 2003).

Information gathered by Orange County Water District indicates that there is no evidence of continuing irreversible subsidence and little potential for future widespread subsidence (OCWD et al. 2022), given Orange County Water District's commitment to sustainable groundwater management and policy of maintaining groundwater storage levels within a specified operating range in its management area, which includes portions of the RSA between Buena Park and ARTIC.

Primary Seismic Hazards

The RSA is within a seismically active region. When faults rupture, they create ground shaking that can be felt hundreds of miles from the source. This section identifies active faults in the seismicity RSA, discusses the surface fault rupture potential relative to the project section, and summarizes the level of potential ground shaking that must be considered for design.

Seismic Setting

The largest historical earthquake in the vicinity of the RSA occurred along the San Andreas fault. The Fort Tejon earthquake (estimated magnitude 7.8) occurred on this fault on January 9, 1857. Strong shaking caused by the earthquake was reported to have lasted for at least 1 minute. Some of the major historical earthquakes in the vicinity of the project section, their magnitude, the distance measured from the epicenter to the midpoint of the project footprint, and direction of the earthquake epicenter are provided in Table 3.9-6.

Table 3.9-6 List of Historical Earthquakes in the Resource Study Area

Earthquake (Oldest to Youngest)	Date of Earthquake	Magnitude (M)	Distance to Epicenter (miles)	Direction to Epicenter
U.S. Highway 101				
Fort Tejon	9-Jan-1857	7.8	207	NW
San Jacinto-Hemet area	21-Apr-1918	6.8	73	SE
Long Beach	10-Mar-1933	6.4	34	SSE
San Clemente Island	26-Dec-1951	5.9	84	S
Tehachapi	21-Jul-1952	7.5	79	NW
San Fernando	9-Feb-1971	6.6	26	NW
Whittier Narrows	1-Oct-1987	5.9	9	E

Earthquake (Oldest to Youngest)	Date of Earthquake	Magnitude (M)	Distance to Epicenter (miles)	Direction to Epicenter
Sierra Madre	28-Jun-1991	5.8	20	NE
Landers	28-Jun-1992	7.3	104	NE
Big Bear	28-Jun-1992	6.3	81	NE
Northridge	17-Jan-1994	6.7	21	NW
Hector Mine	16-Oct-1999	7.1	119	NE
Chino Hills	29-Jul-2008	5.4	28	SE
Sierra El Mayor	4-Apr-2010	7.2	225	SE
La Habra	28-Mar-2014	5.1	20	SE
Ridgecrest	5-Jul-2019	7.1	124	NNE
Ventura	8-Aug-2023	5.1	60	NW
Middle of Alignment				
Fort Tejon	9-Jan-1857	7.8	220	NW
San Jacinto-Hemet area	21-Apr-1918	6.8	62	ESE
Long Beach	10-Mar-1933	6.4	22	S
San Clemente Island	26-Dec-1951	5.9	78	SSW
Tehachapi	21-Jul-1952	7.5	92	NW
San Fernando	9-Feb-1971	6.6	39	NW
Whittier Narrows	1-Oct-1987	5.9	9	N
Sierra Madre	28-Jun-1991	5.8	24	N
Landers	28-Jun-1992	7.3	95	NE
Big Bear	28-Jun-1992	6.3	73	NE
Northridge	17-Jan-1994	6.7	34	NW
Hector Mine	16-Oct-1999	7.1	112	NE
Chino Hills	29-Jul-2008	5.4	17	E
Sierra El Mayor	4-Apr-2010	7.2	211	SE
La Habra	28-Mar-2014	5.1	8	E
Ridgecrest	5-Jul-2019	7.1	130	NNE
Ventura	8-Aug-2023	5.1	73	NW
ARTIC				
Fort Tejon	9-Jan-1857	7.8	233	NW
San Jacinto-Hemet area	21-Apr-1918	6.8	50	E
Long Beach	10-Mar-1933	6.4	14	SW
San Clemente Island	26-Dec-1951	5.9	73	SW
Tehachapi	21-Jul-1952	7.5	106	NW

Earthquake (Oldest to Youngest)	Date of Earthquake	Magnitude (M)	Distance to Epicenter (miles)	Direction to Epicenter
San Fernando	9-Feb-1971	6.6	52	NW
Whittier Narrows	1-Oct-1987	5.9	21	NNW
Sierra Madre	28-Jun-1991	5.8	33	N
Landers	28-Jun-1992	7.3	88	NE
Big Bear	28-Jun-1992	6.3	66	NE
Northridge	17-Jan-1994	6.7	47	NW
Hector Mine	16-Oct-1999	7.1	107	NE
Chino Hills	29-Jul-2008	5.4	12	NE
Sierra El Mayor	4-Apr-2010	7.2	183	SE
La Habra	28-Mar-2014	5.1	9	N
Ridgecrest	5-Jul-2019	7.1	137	NNE
Ventura	8-Aug-2023	5.1	86	NW

Source: SCEDC 2023
ARTIC = Anaheim Regional Transportation Intermodal Center; NW = northwest; SE = southeast; SSE = south by southeast; S = south; E = east; NE = northeast; ESE = east by southeast; SSW = south by southwest; N = north; SW = southwest; NNW = north by northwest

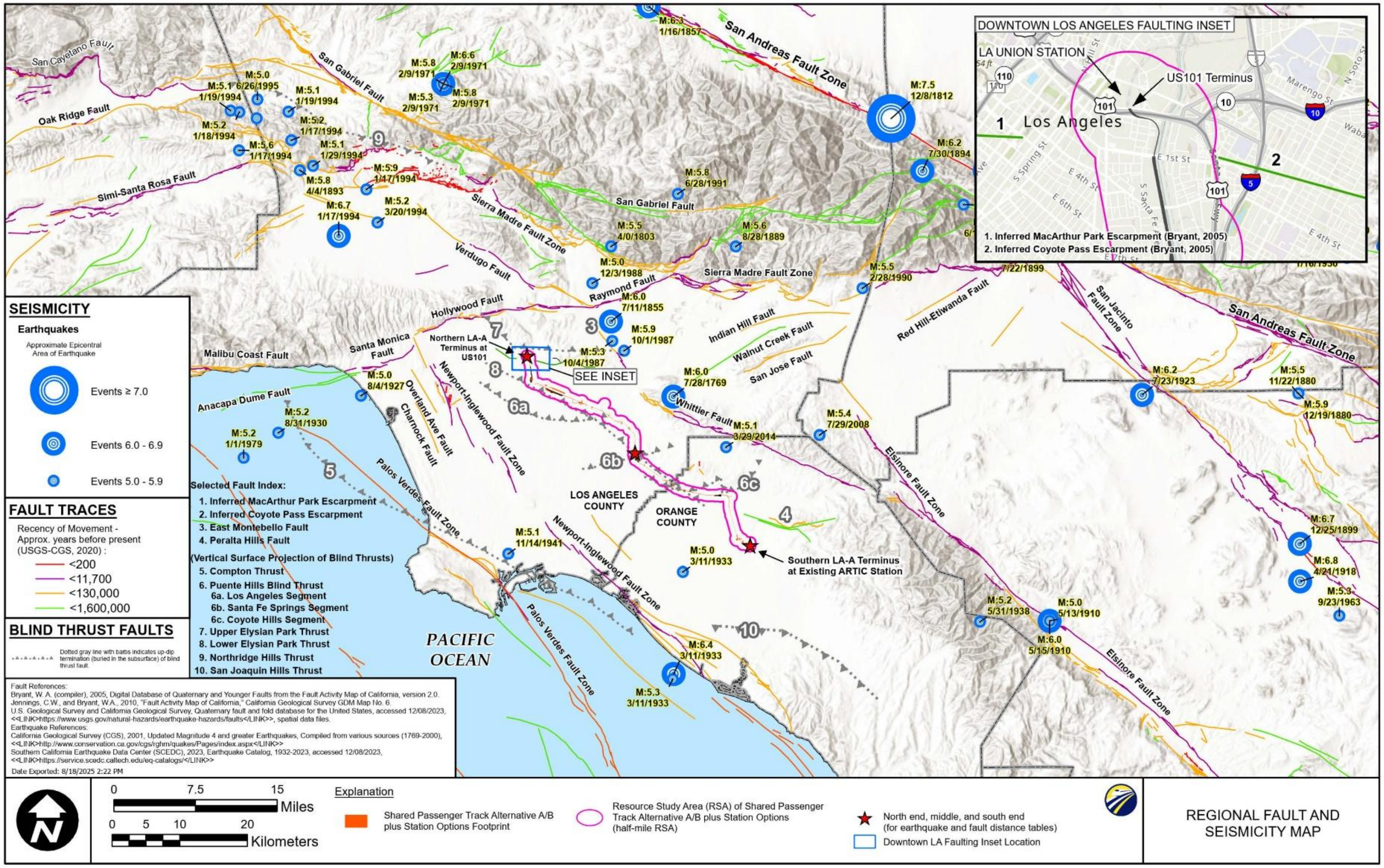
The severity of the potential seismic hazard is related to the geology of the area, distance from the seismic source, and magnitude of the earthquake generated by the seismic source. Primary seismic hazards are those directly associated with earthquakes, including ground surface fault rupture and strong ground shaking. The review of information published by the U.S. Geological Survey and CGS determined the following primary seismic hazards within the seismicity and faulting RSA (Jennings and Bryant 2010; CGS 2018; Cao et al. 2003; Field et al. 2013; SCEDC 2023; USGS and CGS 2023; WGCEP 2016, CDMG 1977, 1991, 1998a–f, 1999a–d; USACE 1974, 1985, 1986; City of Monterey Park 2001).

Surface Fault Rupture

The Peninsular Ranges geomorphic province has historically active faults that generally trend northwest through the region. Figure 3.9-4 depicts faults in the region adjacent to the project section. The faults are color coded to represent four age categories, based on information of when they last ruptured (Jennings and Bryant 2010).

- **Red:** Historical displacement (last approximately 200 years)
- **Brown:** Latest Quaternary displacement (last approximately 11,700 years)
- **Orange:** Middle and Late Quaternary displacement (last 700,000 years)
- **Green:** Undifferentiated Quaternary displacement and Early to Mid-Quaternary displacement (last 1,600,000 years)

Major historical earthquakes have been recorded on some of the faults considered to be active in the region (red colored). A fault is considered active if evidence indicates it has ruptured within the Holocene (last 11,700 years) (CGS 2018).



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; Bryant 2005; CGS 2001a; SCEDC 2023; USGS and CGS 2023

Figure 3.9-4 Regional Fault and Seismicity in the Resource Study Area

The major faults in the vicinity of the project section, their maximum magnitude and the closest distance measured from the fault to the midpoint of the project footprint, and direction of the fault from the site are provided in Table 3.9-7. The distance from U.S. Highway 101, central midpoint, and southern end of the project section to faults considered active by CGS are listed in these tables in their respective order. The distances are an important factor in quantifying the degree of ground motion experienced during a future earthquake event on a nearby or regional fault.

Table 3.9-7 Major Named Faults Considered to Be Active in Southern California in the Resource Study Area

Fault	Maximum Magnitude (M_w)	Geometry	Slip Rate (mm/yr)	Approximate Fault Length (miles)	Distance (miles)	Direction from Project Section
U.S. Highway 101 at Northern Terminus						
Puente Hills blind thrust	7.1	BT	0.9	29	(3.5)[1]	--*
Upper Elysian Park thrust	6.4	BT	1.9	12	2.0[2]	NE
Lower Elysian Park thrust	6.4	BT	1.7	31	7.0[1]	--*
Compton thrust	7.6	BT	0.9	40	10[2]	SW
Hollywood	6.4	RO	0.9	9	4.3	NNW
Raymond	6.5	RO	2.0	16	4.6	NNE
Verdugo	6.9	RO	0.4	13	6.1	NNE
Newport-Inglewood	7.1	SS	1.0	17	7.3	SW
Santa Monica	6.6	RO	1.0	22	10	W
Whittier	6.8	RO	2.5	22	11	SE
Sierra Madre	7.2	RO	2.0	34	12	NE
San Gabriel	7.2	SS	0.4	87	13	N
San Fernando	6.7	RO	2.0	14	16	NNW
Compton thrust	7.6	BT	0.9	40	18[2]	SW
Palos Verdes	7.3	SS	3.0	7	19	SSW
Northridge thrust	7.0	BT	1.5	21	19[2]	NW
Santa Susana	6.7	RO	6.0	22	22	NW
Malibu Coast	6.7	RO	0.3	39	24	W
Simi-Santa Rosa	7.0	RO	0.7	24	26	NW
San Joaquin Hills thrust	6.6	BT	0.5	17	30[2]	SE
Chino	6.7	RO	1.0	12	31	ESE
Cucamonga	6.9	RO	1.5	14	33	ENE
San Andreas (Mojave S. Section)	7.4	SS	34.0	70	34	NE
Elsinore (Glen Ivy Section)	6.8	SS	5.0	29	35	SE

Fault	Maximum Magnitude (M_w)	Geometry	Slip Rate (mm/yr)	Approximate Fault Length (miles)	Distance (miles)	Direction from Project Section
Oak Ridge	7.0	RO	3.0	46	37	NW
San Cayetano	7.0	RO	6.0	28	37	NW
Middle of Alignment						
Puente Hills blind thrust	7.1	BT	0.9	29	(2.0)[3]	S
Whittier	6.8	RO	2.5	22	4.8	SE
Upper Elysian Park thrust	6.4	BT	1.9	12	10[2]	NE
Lower Elysian Park thrust	6.4	BT	1,7	31	(6.2)[3]	
Newport-Inglewood	7.1	SS	1.0	17	10	SW
Compton thrust	7.6	BT	0.9	40	(7.5)[2]	SW
Raymond	6.5	RO	2.0	16	14	NNE
Sierra Madre	7.2	RO	2.0	34	16	NE
Palos Verdes	7.3	SS	3.0	7	16	SSW
San Joaquin Hills thrust	6.6	BT	0.5	17	18[2]	SE
Hollywood	6.4	RO	0.9	9	18	NW
Verdugo	6.9	RO	0.4	13	18	NNE
Chino	6.7	RO	1.0	12	21	ESE
Santa Monica	6.6	RO	1.0	22	22	W
San Gabriel	7.2	SS	0.4	87	22	N
Elsinore (Glen Ivy Section)	6.8	SS	5.0	29	23	SE
Cucamonga	6.9	RO	1.5	14	27	ENE
San Fernando	6.7	RO	2.0	14	28	NNW
Northridge thrust	7.0	BT	1.5	21	32[2]	NW
Malibu Coast	6.7	RO	0.3	39	35	W
Santa Susana	6.7	RO	6.0	22	35	NW
San Andreas (Mojave S. Section)	7.4	SS	34.0	70	38	NE
San Jacinto	6.7	SS	6.0	32	43	ENE
ARTIC						
Lower Elysian Park thrust	6.4	BT	1.7	31	5.1[4]	NW
Puente Hills blind thrust	7.1	BT	0.9	29	5.2[4]	NW
San Joaquin Hills thrust	6.6	BT	0.5	17	7.6[4]	S
Whittier	6.8	RO	2.5	22	9.0	NE

Fault	Maximum Magnitude (M_w)	Geometry	Slip Rate (mm/yr)	Approximate Fault Length (miles)	Distance (miles)	Direction from Project Section
Newport-Inglewood	7.1	SS	1.0	17	11	SW
Compton thrust	7.6	BT	0.9	40	7.5[4]	W-SW
Elsinore (Glen Ivy Section)	6.8	SS	5.0	29	13	NE
Chino	6.7	RO	1.0	12	15	NE
Upper Elysian Park thrust	6.4	BT	1.9	12	23[4]	NW
Palos Verdes	7.3	SS	3.0	7	23	WSW
Raymond	6.5	RO	2.0	16	26	NNW
Sierra Madre	7.2	RO	2.0	34	27	NNW
Cucamonga	6.9	RO	1.5	14	27	NNE
Hollywood	6.4	RO	0.9	9	31	NW
Verdugo	6.9	RO	0.4	13	31	NNW
San Gabriel	7.2	SS	0.4	87	32	NNW
Santa Monica	6.6	RO	1.0	22	36	NW
San Andreas (San Bernardino Section)	7.5	SS	19.0	80	40	NE
San Fernando	6.7	RO	2.0	14	41	NNW
Northridge thrust	7.0	BT	1.5	21	42[4]	NW
Malibu Coast	6.7	RO	0.3	39	48	WNW
Santa Susana	6.7	RO	6.0	22	50	NW

Sources: Cao et al. 2003; Field et al. 2013; SCEDC 2023; USGS and CGS 2023
Sources: (a) = Cao et al. 2003; Field et al. 2013; (b) = USGS and CGS 2023; (c) = SCEDC 2023; faults within 50 miles of northern terminus of alignment
Blind thrust faults are considered active seismogenic faults but do not pose a potential surface rupture hazard.
[1] Values in parenthesis are perpendicular distance from buried blind thrust fault plane beneath alignment footprint at northern terminus based on plot location from USGS and CGS 2023. Blind Thrust faults are considered active seismogenic faults but do not pose a potential surface rupture hazard. Refer to text for discussion.
[2] Closest distance to the vertical projection of the buried up-dip termination of the thrust fault plane in the subsurface based on plot location from USGS and CGS 2023.
[3] Value in parenthesis is the horizontal map distance to the vertical projection of the buried up-dip termination of the thrust fault based on plot location from USGS and CGS 2023.
[4] Closest distance to the buried up thrust fault plane in the subsurface, based on plot location from USGS and CGS 2023.
Geometry: BT = Blind Thrust; NO = Normal Oblique; RO = Reverse Oblique; SS = Strike-Slip
ARTIC = Anaheim Regional Transportation Intermodal Center; HSR = high-speed rail; mm/yr = millimeter per year; M_w = moment magnitude; N = north; n/a = not applicable; NE = northeast; NNE = north by northeast; NNW = north by northwest; NW = northwest; NW = northwest; project section = Los Angeles to Anaheim Project Section; S = south; SW = southwest; W = west; WSW = west by southwest

According to the State of California Special Studies Zones Maps for the Los Angeles Quadrangle (CDMG 1977) and La Habra Quadrangle (CDMG 1991), the RSA does not cross into an Alquist-Priolo Earthquake Fault Zone (Hart and Bryant 2007). Moreover, the Fault Activity Map of California, prepared by the CGS (Jennings and Bryant 2010), indicates no Holocene active or Late Quaternary age faults (displacement within the last approximately 700,000 years) with potential to cause surface fault rupture crossing the project section. The Puente Hills blind thrust

(PHT) fault[5] and the other blind thrust faults listed in Table 3.9-7 (i.e., Upper Elysian Park, Compton, Northridge, and San Joaquin thrust faults) are buried deep in the subsurface (at a minimum depth greater than 0.7 mile) and therefore are not surface rupture hazards. The term *blind thrust fault* refers to a fault that has several geometric attributes, including a relatively shallow dip angle, reverse sense of displacement, and the uppermost portion of the fault plane that terminates some depth below the ground surface. Although these blind thrust faults do not reach the ground surface and therefore are not a surface fault rupture hazard, they are considered active features from a ground shaking perspective and are a source for potential folding/tilting in the near surface. Most notably, the PHT fault generated the 1987 Whittier Narrows earthquake (magnitude 6.0).

Seismic Ground Shaking

The RSA is in proximity to major faults capable of producing moderate to large earthquakes. A list of the nearby faults along with the approximate closest distance from the RSA to these faults is presented in the *Los Angeles to Anaheim Project Section Geology, Soils, And Seismicity Technical Report* (Authority 2025a). The RSA contains both strike-slip faults and thrust faults (Cao et al. 2003; Field et al. 2013; SCEDC 2023; USGS and CGS 2023; WGCEP 2016). In general, earthquakes on thrust faults produce higher ground accelerations and stronger ground motions than earthquakes on strike-slip faults (USGS 2013).

The level of ground shaking along the RSA was estimated following procedures in the 2022 California Building Standards Code. Results of this evaluation indicate that the project section would be subject to strong seismic shaking from moderate to large earthquakes occurring along the major active faults in the region. The intensity of the ground shaking at a given location depends primarily on the earthquake magnitude, source-to-site distance, fault length, style of faulting, dip angle, and slip rate, among several other factors. The peak horizontal ground acceleration along the project alignment ranges from 0.68 g to 0.87 g, meaning that the perceived shaking would be severe and potential damage moderate to heavy.

Secondary Seismic Hazards

A number of secondary seismic hazards could occur along the project section and stations, if there is strong ground shaking in the vicinity of the RSA. The strong ground shaking could result from either nearby or distant earthquakes, depending on the combination of earthquake magnitude and distance from the RSA. These secondary hazards include liquefaction, seismically induced slides or slumps, and floods resulting from seismically induced dam failure. The following sections discuss these hazards and where they may occur.

Liquefaction

Soil liquefaction is the process by which the shear strength of granular-saturated soils is reduced because of an increase in pore pressure during seismic shaking. Requisite conditions for liquefaction to occur include saturated granular soils and nonplastic silt that are not free-draining, with a loose-packed grain structure capable of progressive rearrangement of grains during repeated cycles of seismic loading. When liquefaction occurs, the particles rearrange to a denser state, but excess pore pressure is not dissipated; therefore, the shear strength of the soil decreases, thus reducing the soil’s ability to support foundations for buildings and bridges. The stability of slopes may also be reduced, as discussed under lateral spreading.

Relatively loose to medium-dense granular alluvium and shallow groundwater (less than 50 feet below ground surface) is present along portions of the project section (CDMG 1998a–f, 1999a–d). The level of ground shaking anticipated during a moderate to large earthquake event in Southern

[5] The up-dip terminus of the Puente Hills blind thrust fault tip is buried approximately 1.7 miles beneath the ground surface. It therefore does not present a surface fault rupture hazard.

California is sufficient to cause liquefaction of loose, saturated, cohesionless soil, and would warrant special consideration during structural design. Therefore, the risk of liquefaction within the RSA is considered substantial.

The State of California Seismic Hazard Zone Maps delineate areas as being susceptible to liquefaction if past occurrence of liquefaction was reported or local geological, geotechnical, and groundwater conditions suggest a potential for liquefaction exists. Review of the Seismic Hazard Zones Maps for the Los Angeles, South Gate, Whittier, La Habra, Anaheim, and Orange 7.5-Minute quadrangles (CDMG 1998a–f, 1999a–d) indicates that the project section would cross several large areas mapped as being potentially susceptible to liquefaction. Seismic hazard areas in the RSA are depicted on Figure 3.9-5 (sheets 1 through 3). Liquefaction hazard zones are indicated in green.

Seismic settlement in dry and partially saturated soils is often caused by loose to medium-dense granular soils because of densification during ground shaking. Uniform settlement beneath a given structure would cause minimal damage; however, because of variations in distribution, density, and confining conditions of the soils, seismically induced settlement is generally nonuniform and can cause structural damage.

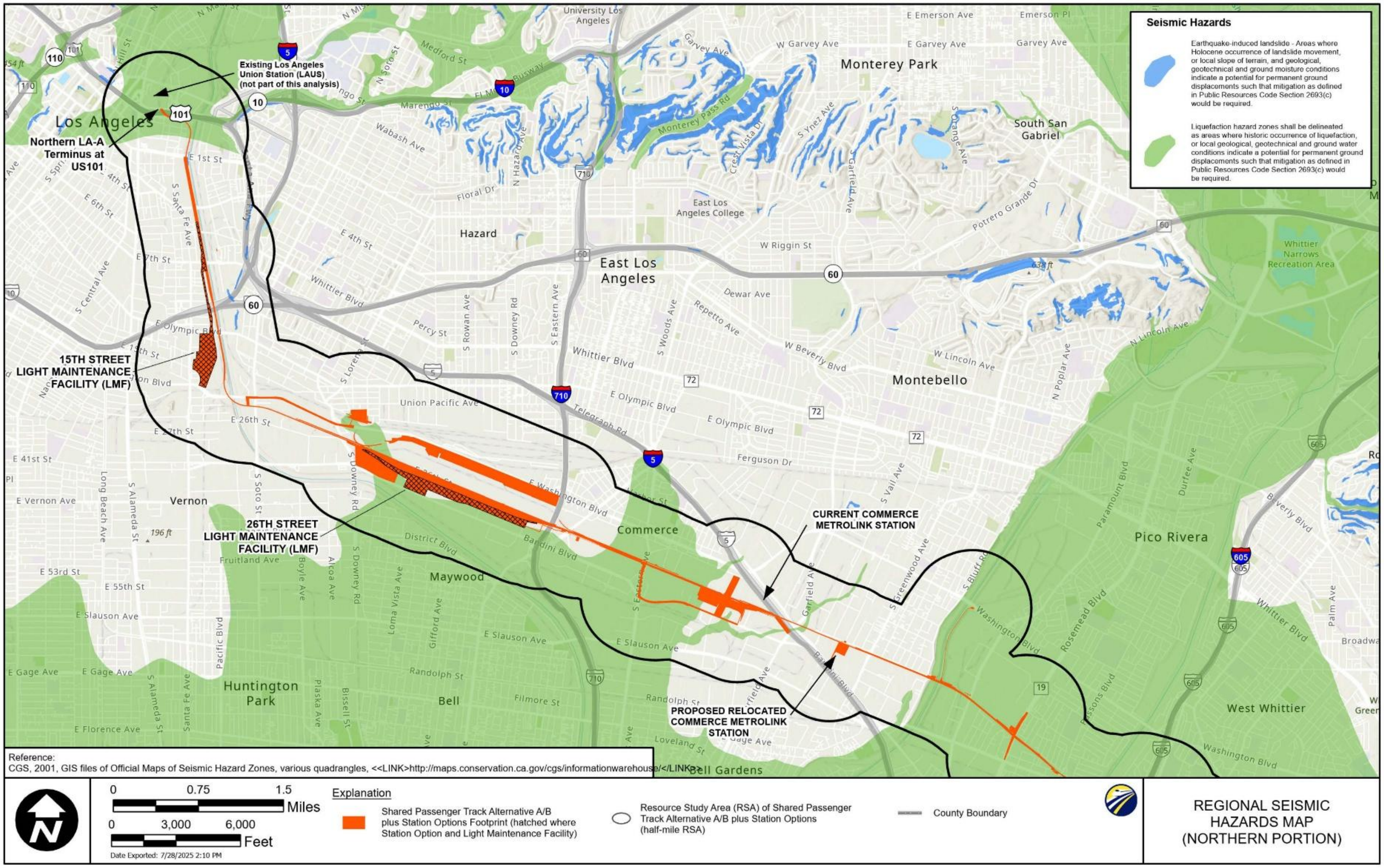
Lateral Spreading

One of the consequences of seismic liquefaction in sloping ground areas is the phenomenon known as lateral spreading, which refers to the translation of land laterally after the loss of support caused by liquefaction. For this to occur, the liquefied area must be relatively near a free face, a vertical or sloping face such as a road cut or stream/river bank. The RSA is relatively flat; therefore, the probability for lateral spreading in response to the liquefaction of subsurface soil is low. However, there is a possibility that localized lateral spreading may occur in areas where the project section crosses over creeks and river channels.

Seismically Induced Landslide Hazards

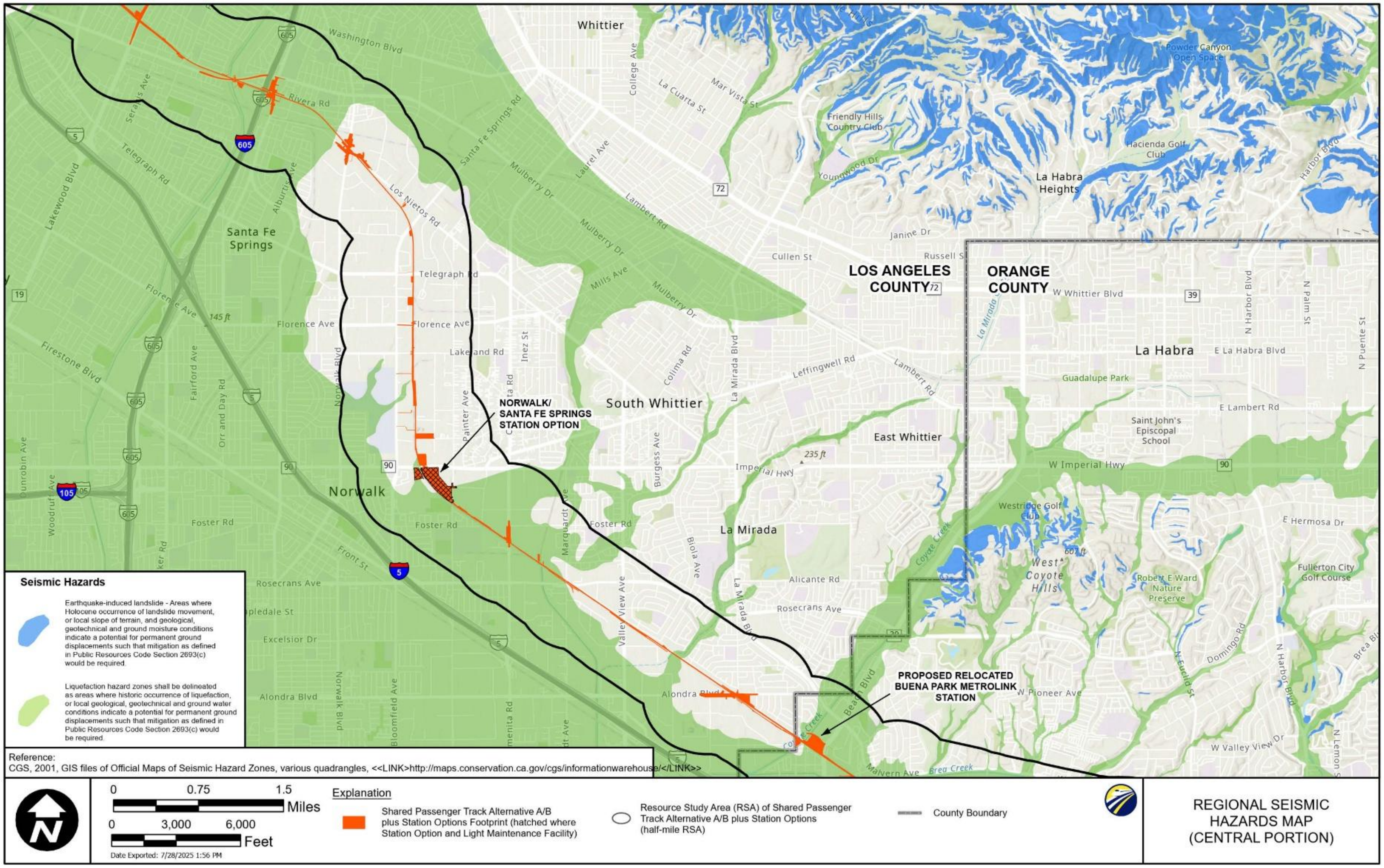
Seismically induced landslides occur when shaking from an earthquake causes pre-existing landslides to reactivate or triggers new landslides along planes of weakness in bedrock material. Marginally stable slopes may be subject to landslides caused by seismic shaking. In most cases, this is limited to relatively shallow soil failures on the steeper natural slopes, although deep-seated failures of over-steepened slopes are also possible. According to the Seismic Hazard Zones Map for the Los Angeles, South Gate, Whittier, La Habra, Anaheim, and Orange 7.5-Minute quadrangles (CDMG 1998a–f, 1999a–d), the RSA would not be within mapped zones with potential for seismically induced landslides. The nearest seismically induced landslide zones mapped by CGS are approximately 1,000 feet east of the project footprint, east of the Los Angeles River, near downtown Los Angeles, based on the Seismic Hazard Maps quadrangles. Therefore, seismically induced landslide hazard is not considered a potential seismic hazard for the project.[6]

[6] IAMFs as discussed in Impact GSSPR-2 would reduce impacts.



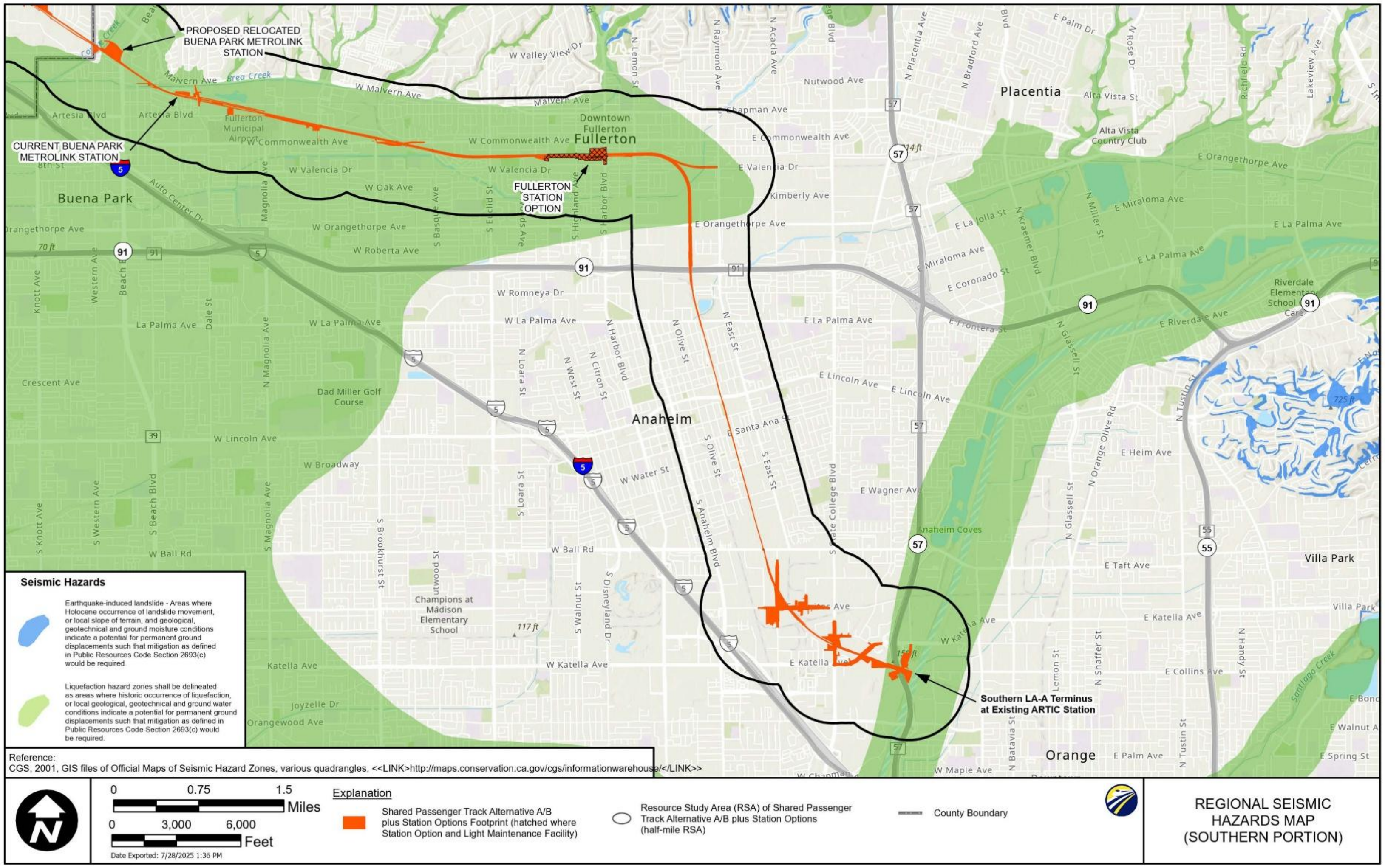
Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; CGS 2001b

Figure 3.9-5 Seismic Hazards in the Resource Study Area, Sheet 1 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; CGS 2001b

Figure 3.9-5 Seismic Hazards in the Resource Study Area, Sheet 2 of 3



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; CGS 2001b

Figure 3.9-5 Seismic Hazards in the Resource Study Area, Sheet 3 of 3

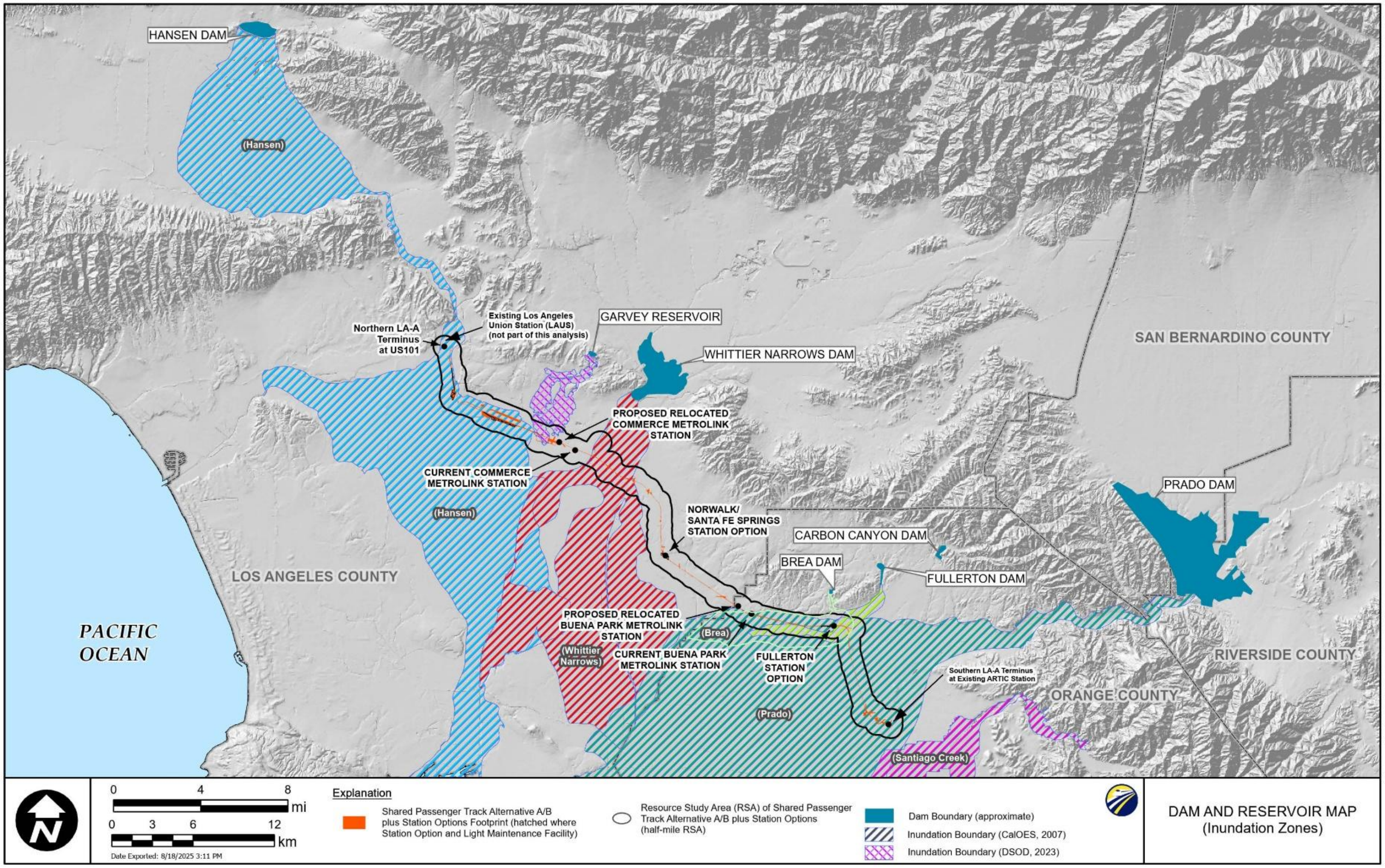
Seismically Induced Flood Hazards

Seismically induced flooding is defined in the *Los Angeles to Anaheim Project Section Geology, Soils, And Seismicity Technical Report* (Authority 2025a) as flooding caused by failures of dams or other water-retaining structures caused by seismic shaking, resulting in damage to structures and properties downstream and consequently possible injuries or loss of life. Seismically induced flooding could also potentially occur during strong seismic shaking if a dam were to overtop as a result of a seiche.[7] However, failures of dams are more often caused by foundation failures, piping and internal erosion, overtopping caused by floods and inadequate capacity or inadequate spillways, and poor construction. The statutes governing dam safety in California are included in Division 3 of the Water Code and place responsibility of dam safety under the jurisdiction of the California Water Resources Division of Safety of Dams.

Dam inundation maps for California dams are under the jurisdiction of the California Office of Emergency Services, whose Dam Safety Program coordinates with other state and federal agencies to ensure effective dam incident emergency response procedures and planning. Inundation maps are approximations of the maximum water surface extent resulting from a complete dam breach and draining of the full reservoir. The resultant maps are to be used to identify risk for planning purposes, because they represent the worst-case scenario for a total failure of a dam.

Several flood-control dams and reservoirs are upgradient of the RSA. In the northern and central portions, these include the Hansen Dam in the city of Los Angeles, Garvey Reservoir in Monterey Park, and Whittier Narrows Dam in eastern Los Angeles County. Dams in the southern portion include the Brea Dam, Fullerton Dam, Carbon Canyon Dam, and Prado Dam. Dams in the RSA are depicted on Figure 3.9-6. These dams are flood-control structures and are therefore rarely full.

[7] *Seiche* refers to the movement of an enclosed body of water such as a bay, lake, river, or reservoir caused by periodic oscillation. Seiches commonly occur as a result of intense seismic shaking or catastrophic landslides displacing large amounts of water in a short period of time. The period of oscillation varies and depends on the waterbody size. The period of a seiche can last for minutes to several hours and depends on the magnitude of oscillations as well as the geometry of the waterbody. Seiches have been recorded to cause substantial damage to nearby structures, including dams, shoreline facilities, and levees or embankments.



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; CalOES 2007; DSOD 2023

Figure 3.9-6 Dams in the Resource Study Area

The California Department of Water Resources' Division of Safety of Dams annually inspects each dam to ensure the dam is safe, performing as intended, and not developing problems. The Division of Safety of Dams also periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California.

All the dams above, with the exception of Garvey Reservoir, are part of the U.S. Army Corps of Engineers' Dam Safety Program. The purpose of the Dam Safety Program is to maintain public safety by ensuring dams owned and operated by the U.S. Army Corps of Engineers are safe and risks to the public are minimized. The U.S. Army Corps of Engineers has performed screening portfolio risk analyses on its dams. Based on the risk analyses performed by the U.S. Army Corps of Engineers, interim risk reduction measures have been implemented for Hansen Dam, Whittier Narrows Dam, Brea Dam, Carbon Canyon Dam, and Prado Dam. These measures include inspection by a special dam inspection team when the reservoir elevations reach a predetermined trigger, updates of emergency action plans, coordination with downstream agencies, and other monitoring or specialized investigations.

Hansen Dam is approximately 24 miles upstream of the northern end of the project section in the northeast San Fernando Valley at the confluence of the Big and Little Tujunga Washes. It is an earthen embankment with a crest height of 97 feet. An 11-acre recreational lake is within the reservoir basin. In case of a complete breach of the dam at maximum reservoir capacity, the worst-case inundation pathway would spread southward through a large portion of the San Fernando Valley, then would funnel through the Los Angeles Narrows area (north of downtown Los Angeles) (USACE 1986). South of downtown Los Angeles, the inundation pathway would spread largely to the southeast and would cross a part of the northern portion of the project section.

Garvey Reservoir is approximately 4.5 miles northeast of the project section. The reservoir area is 38 acres in size and is impounded by two earthen embankment dams. The inundation map indicates that a portion of the inundation pathway would cross the northern portion of the project section in the Commerce area (City of Monterey Park 2001). The Whittier Narrows Dam and Flood Control Basin is about 3 miles upstream of the central portion of the project section. The dam is on the San Gabriel River in Montebello, California, upstream of the Rio Hondo Percolation Basin. It is a 56-foot-tall earthen dam. The worst-case inundation pathway of the dam at maximum capacity would spread to the southwest and cross the project section in Pico Rivera (USACE 1974).

The Brea Dam is approximately 1.5 miles northeast of the project section. The Brea Dam controls 22 square miles of drainage area of Brea Creek and its tributaries within the San Gabriel River Basin. The worst-case inundation pathway of the dam at maximum capacity would spread to the southwest and cross the project section in Buena Park and Fullerton (USACE 1974).

The Fullerton Dam is approximately 2.5 miles northeast of the project section. It controls 5 square miles of drainage area of Fullerton Creek and its tributaries. Its construction is earthen embankment. The worst-case inundation pathway of the dam at maximum capacity would spread to the southwest and cross a small portion of the project section between Harbor Boulevard and Raymond Avenue in Fullerton (USACE 1974).

Carbon Canyon Dam is along Carbon Creek approximately 7 miles upstream of the project section. This earthen dam controls a drainage area of approximately 19 square miles. The worst-case inundation pathway of the dam at maximum capacity would spread to the southwest and cross a portion of the project section in Buena Park and Fullerton (USACE 1974).

The Prado Dam is on the Santa Ana River in Riverside County, approximately 18 miles upstream of ARTIC and approximately 2 miles west of Corona. Portions of the reservoir are in Riverside and San Bernardino Counties. The dam is at the upper end of the Lower Santa Ana River Canyon, a natural constriction controlling 2,255 square miles of the 2,450-square-mile Santa Ana River watershed. The dam is embankment construction. The worst-case inundation pathway of the dam at maximum capacity would spread to the southwest and cross a portion of the project section in Buena Park, Fullerton, and Anaheim (USACE 1985).

More Information on these dams is found in the *Los Angeles to Anaheim Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2025a).

Table 3.9-8 summarizes primary and secondary seismic hazards in the RSA.

Table 3.9-8 Summary of Seismic and Secondary Seismic Hazards by City in the Resource Study Area

City	Surface Fault Rupture	Liquefaction Potential Zone	Lateral Spreading	Seismically Induced Landslides	Tsunami	Seismically Induced Flooding[1]
Los Angeles	No	Yes	Yes	No	No	Yes (low)
Vernon	No	Yes	Yes	No	No	Yes (low)
Bell	No	Yes	Yes	No	No	Yes (low)
Commerce	No	Yes	Yes	No	No	Yes (low)
Montebello	No	No	No	No	No	Yes (low)
Pico Rivera	No	Yes	Yes	No	No	Yes (low)
West Whittier–Los Nietos Census Designated Place	No	Yes	Yes	No	No	Yes (low)
Santa Fe Springs	No	Yes	Yes	No	No	Yes (low)
Norwalk	No	Yes	Yes	No	No	Yes (low)
La Mirada	No	Yes	Yes	No	No	Yes (low)
Buena Park	No	Yes	Yes	No	No	Yes (low)
Fullerton	No	Yes	Yes	No	No	Yes (low)
Anaheim	No	Yes	Yes	No	No	Yes (low)

[1] The risk of exposure to flooding with the project footprint as a result of dam failure is no greater than existing conditions and would not expose people or structures to potential loss of life, injury, or destruction beyond what they are exposed to currently in the resource study area.

Areas of Difficult Excavation

Earth materials within the RSA are alluvial deposits that, in general, are expected to be easily ripped with modern earthmoving equipment in good working order. There are no areas of shallow bedrock in the project footprint; however, some areas along the project section, most likely near the Los Angeles and San Gabriel River channels, may encounter cobble- to boulder-sized material. In addition, potential areas of old fill may contain oversize materials. Boulders may occur adjacent to the major river crossings; if encountered in excavations or during drilling foundations, they may require special handling and drilling equipment.

Geological Resources

Geological resources in California include oil and gas fields, geothermal fields, and a wide range of mineral resources. The principal constraint associated with oil, gas, geothermal, and mineral resources is the need for planning to ensure that construction of new facilities would not conflict with the removal of economically important resources and would avoid known resource areas to the extent feasible. In addition, the presence of even small (noneconomic) quantities of oil or gas in the subsurface can under certain circumstances pose toxic or explosive hazards during construction, requiring specific precautions, and may also necessitate special designs and monitoring during the operation of subsurface structures.

Mineral Resources

The RSA traverses areas underlain by geologic materials such as sand and gravel that may be considered mineral resources and could be used as construction aggregate. However, these materials have been mined only in limited areas, about 1 to 2 miles northwest of ARTIC adjacent to the Santa Ana River, now abandoned. There are no active mineral producers along the RSA. The project is exempt from Mineral Resource Zone zoning under Article 1, Section 2714(b) of the Surface Mining and Reclamation Act. Mineral Resource Zones in the RSA are summarized in Table 3.9-9.

Fossil Fuel Resources (Oil and Natural Gas)

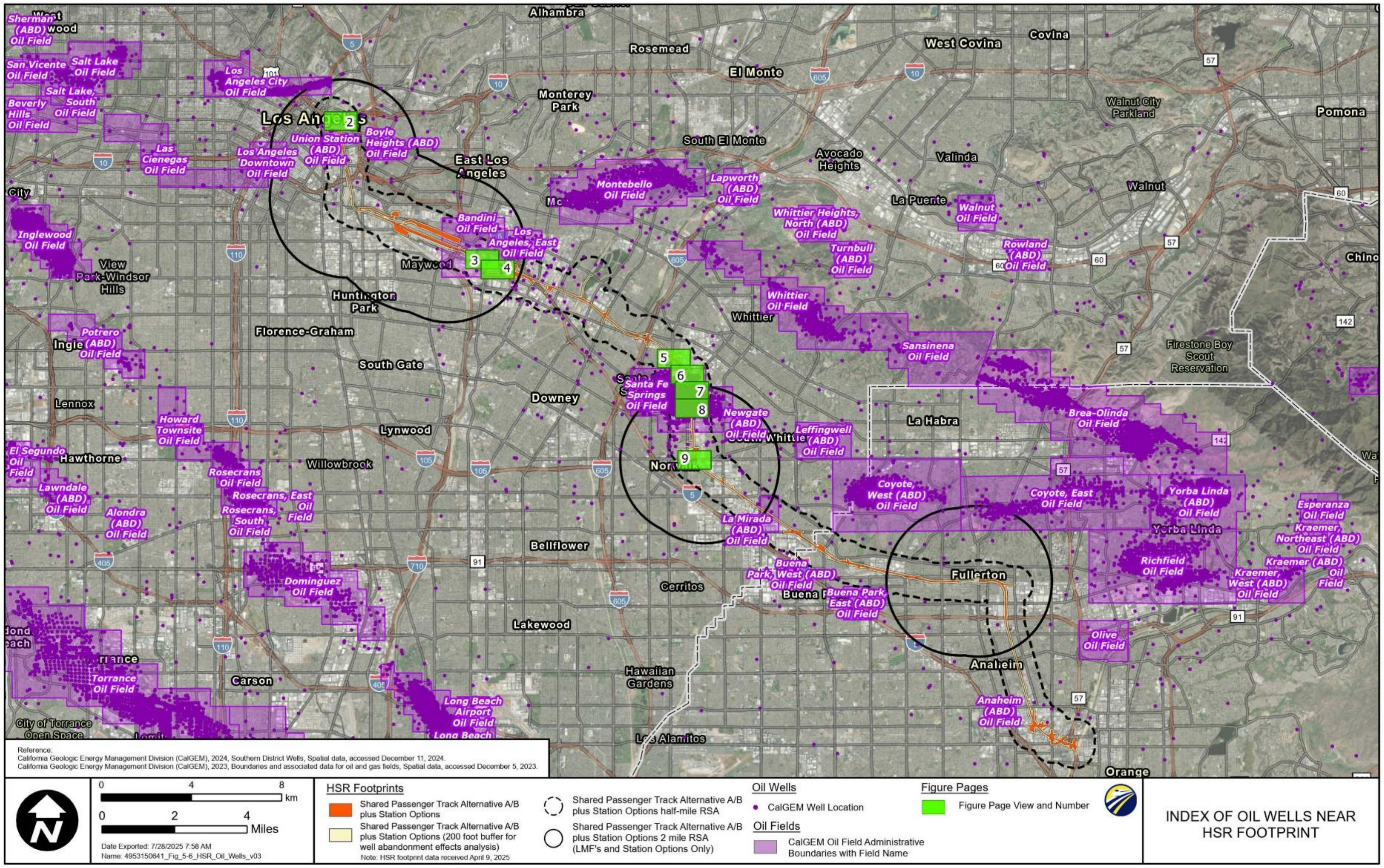
The northern segment of the Shared Passenger Track Alternatives would cross part of the Union Station oil field (abandoned) and Bandini oil field (active). The southeastern boundary of the Los Angeles City oil field is approximately 1 mile northwest of the U.S. Highway 101 northern terminus. The central portion of the Shared Passenger Track Alternatives is underlain by the Santa Fe Springs oil field (active), and the southern portion is in proximity to several abandoned oil fields such as the Anaheim, East and West Buena Park, and La Mirada oil fields. According to CalGEM GIS data, 103 active wells are within the resource hazards RSA, equating to 7 percent of the total wells in the RSA (CalGEM 2023a). In addition, 1,445 buried wells, idle wells, or plugged abandoned wells, or 93 percent of the total wells, are in the RSA. The active oil fields are already established and producing oil fields, and fossil fuel production comes from depths that are far below the ground surface. Although hazardous subsurface gases, including methane and hydrogen sulfide, which can occur naturally in soil, rock, or groundwater, may be found within the RSA, wells present are widely spaced and directionally drilled, and are therefore not anticipated to present a hazard. Oil fields and wells along the RSA are summarized in Table 3.9-9 and depicted on Figure 3.9-7; detailed map sheets are available in the *Los Angeles to Anaheim Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2025a). Refer also to oil and gas wells discussion in Section 3.10.5, Affected Environment, in Section 3.10, Hazardous Materials and Wastes.

Table 3.9-9 Summary of Mineral, Oil and Gas, and Geothermal Resources by City in the Resource Study Area

City	Mineral Resources[1]	Active Oil Field and Natural Gas	Geothermal
Los Angeles	MRZ-2 / MRZ-3	Yes	No
Vernon	MRZ-1	No	No
Bell	MRZ-1	No	No
Commerce	MRZ-1	No	No
Montebello	MRZ-1 / MRZ-3	No	No
Pico Rivera	MRZ-3	No	No
West Whittier–Los Nietos Census Designated Place	MRZ-1	No	No
Santa Fe Springs	MRZ-1	Yes	No
Norwalk	MRZ-1	No	No
La Mirada	MRZ-1	No	No
Buena Park	MRZ-1	No	No

City	Mineral Resources[1]	Active Oil Field and Natural Gas	Geothermal
Fullerton	MRZ-1	No	No
Anaheim	MRZ-3	No	No

[1] MRZ-1: Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence
MRZ-2: Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence
MRZ-3: Areas containing mineral deposits, the significance of which cannot be evaluated from available data
MRZ-4: Areas where available information is inadequate for assignment to any other MRZ
MRZ = Mineral Resource Zone



Sources: ESRI 2024a, 2024b, 2024c; Rail Data Provided on November 14, 2023; CalGEM 2023a, 2023b

Figure 3.9-7 Oil Fields and Wells in the Resource Study Area

Geothermal Resources

The CalGEM California Geothermal Map (CalGEM 2001) and California Division of Mines and Geology Geothermal Resources Map (CDMG 1980) indicate that the RSA would not be in or near a Geothermal Resource Area as classified by CalGEM. Additionally, no producing or abandoned geothermal wells or geothermal springs are along the project section.

Methane Zones

The northern portion of the project section alignment traverses an area associated with the Union Station oil field, which has been mapped as being within a methane zone by the City of Los Angeles. A second, smaller methane zone, including the associated methane buffer zone, in the city of Los Angeles, runs from north to south between Interstate 10 and Washington Boulevard, and from west to east between Santa Fe Avenue and Soto Street. The central portion of the project section alignment crosses the Santa Fe Springs oil field, which has been identified as a methane zone within Santa Fe Springs (City of Santa Fe Springs 2022). A methane zone has not been mapped yet for the Bandini oil field; however, there is a possibility that methane could be encountered in the subsurface in this oil field. Common problems associated with oil field properties include methane and hydrogen sulfide soil gas, oil seepage, contaminated soils, leaking wells, and wells not plugged and abandoned to current standards.

Several former municipal landfills (closed) and landfills composed of unknown wastes are adjacent to the project footprint in Vernon, Pico Rivera, and Santa Fe Springs, based on maps prepared by the County of Los Angeles Department of Public Works (County of Los Angeles 2017). Methane is a potential gas that could be encountered beneath municipal landfills. The City of Santa Fe Springs has delineated methane zones around several former landfills.

3.9.5.2 Paleontological Resources

Geologic Units in the Resource Study Area

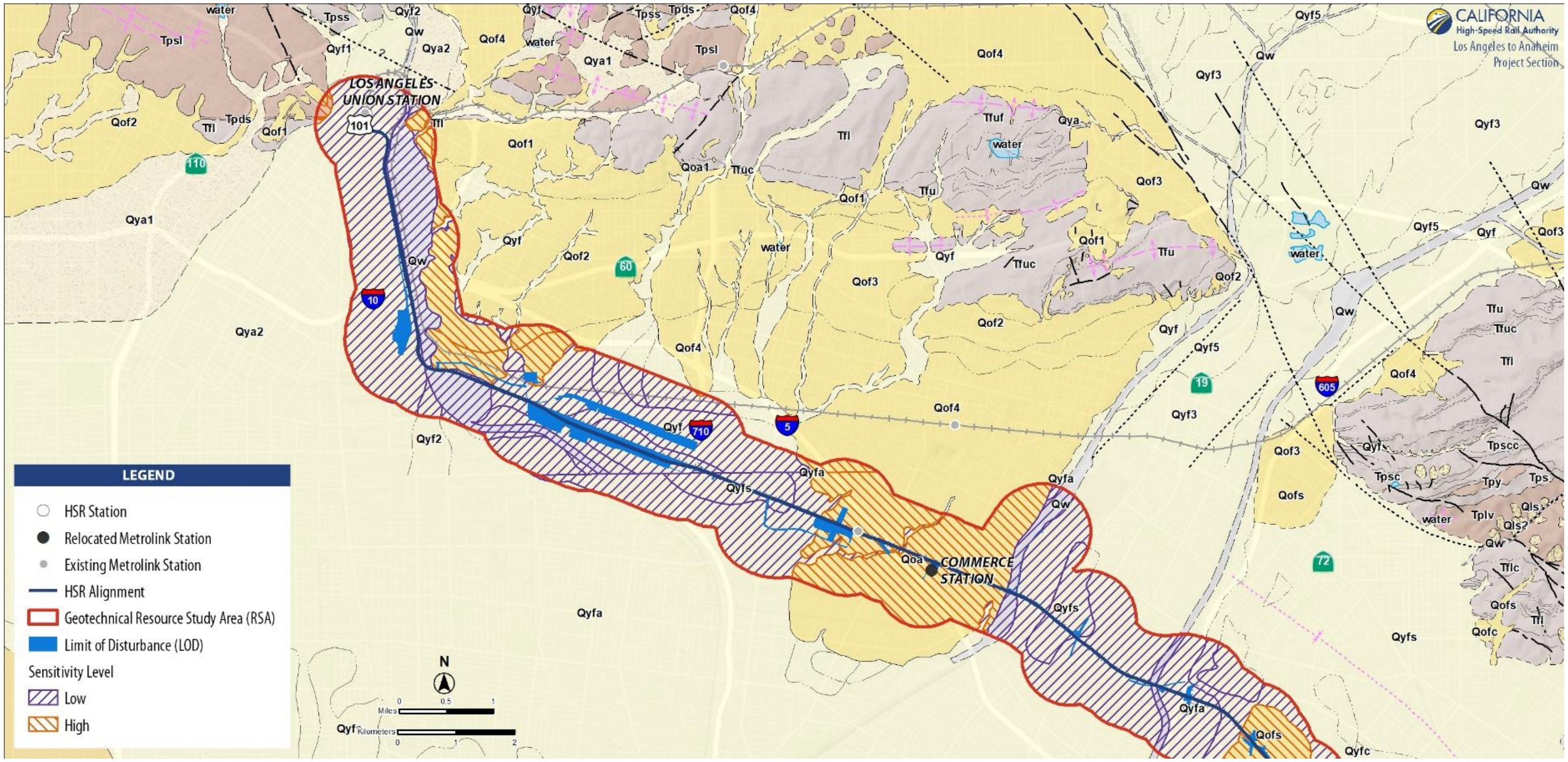
Figure 3.9-8 (sheets 1 through 3) indicates where paleontologically sensitive materials are exposed at the surface in the paleontological resources RSA. The *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b) presents a complete set of geologic maps for the project, developed using 1:24,000-scale U.S. Geological Survey geologic mapping. Table 3.9-10 lists surface-exposed units as well as units known and potentially present in the shallow subsurface within the anticipated volume of disturbance. Table 3.9-10 briefly describes each geologic unit within the paleontological resources RSA, focusing on documented fossil content; more detailed information is presented in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

An inventory of the paleontological resources of each of the geologic units exposed at the surface in the RSA or present in the shallow subsurface is provided below and summarized in Table 3.9-10. These are presented by increasing geologic age; i.e., stratigraphic depth. These geologic units may be found throughout the RSA.

Table 3.9-10 Paleontological Resources of Geologic Units in the Resource Study Area

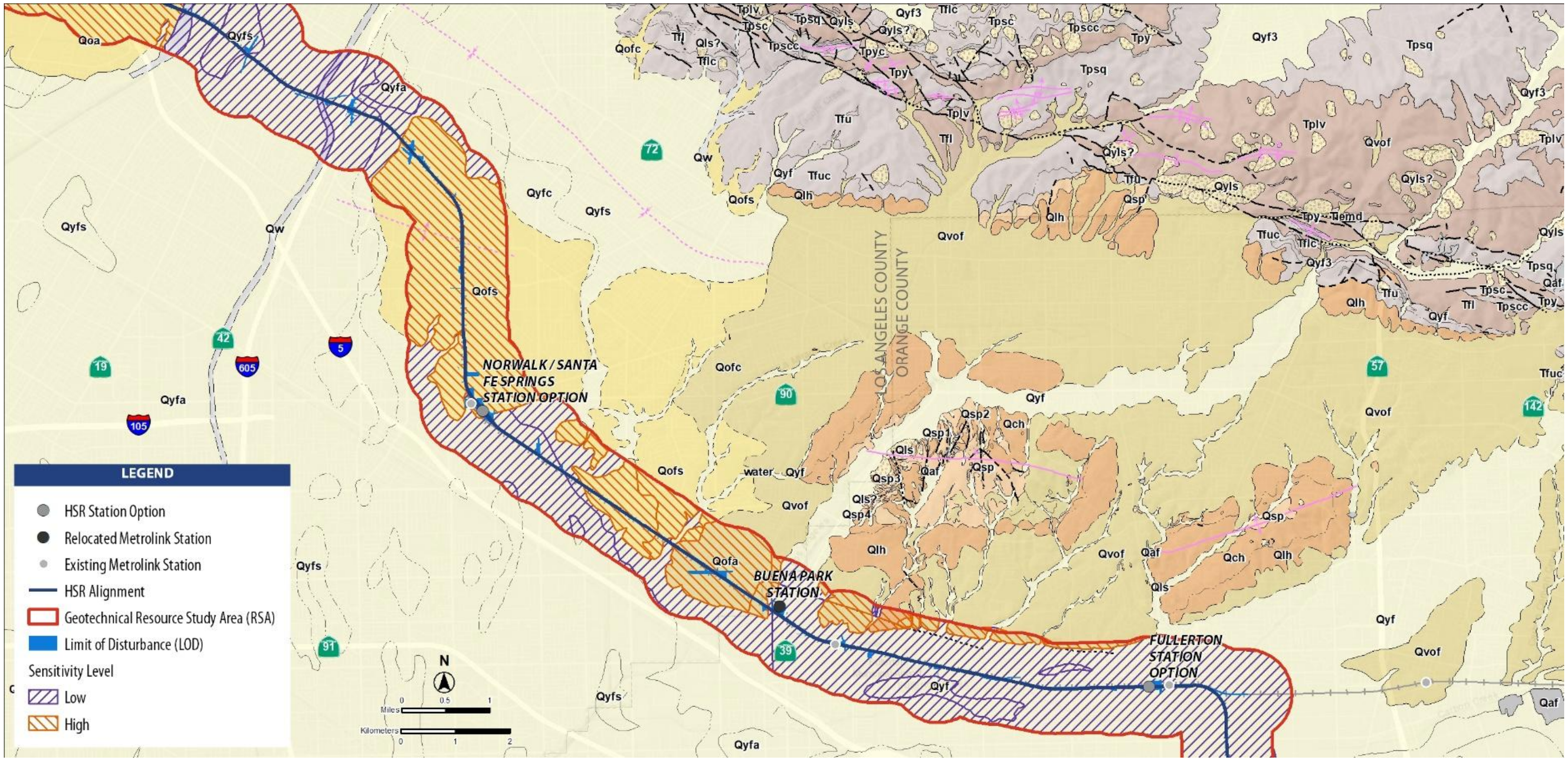
Geologic Unit	Paleontological Sensitivity (per SVP Guidelines)	Age	Known Fossil Content
Wash Deposits	Low	5,000 years BP to the present	None
Younger Quaternary Alluvium	Low at the surface High at depths exceeding approximately 6 feet	11,000 years BP to the present	American mastodons, Columbian mammoths, horses, western camels, antique bison, ground sloths, dire wolves, coyotes, gray foxes, black bears, bobcats, mule deer, cottontails, rodents, Botta's pocket gophers, deer mice, California voles, birds, frogs, pond turtles, lizards, salamanders, snakes, fishes, brackish-water ostracods, freshwater snails and clam and land snails, brackish-water ostracods, freshwater snails and clam and land snails
Older Quaternary Alluvium	High	126,000 years BP to 11,000 years BP	Rancholabrean fauna: ground sloths, American lions, saber-tooth cats, dire wolves, American mastodons, Columbian mammoths, western horses, California tapirs, peccaries, western camels, large-headed llamas, pronghorns, shrub oxen, antique and long-horn bison. Also insectivores (shrews, moles), bats, rabbits, rodents, salamanders, frogs and toads, turtles, lizards, snakes, birds, arachnids (spiders, scorpions), ostracods (aquatic bivalved crustaceans), isopods (sow bugs), millipedes, centipedes, insects, freshwater snails and clams, land snails, freshwater fishes, freshwater algae, gymnosperms, angiosperms
Plio-Pleistocene Repetto Member, Fernando Formation	High	2,000,000 years to 5,000,000 years BP	Sharks rays, fishes, whales and porpoises, otters; birds, sponges, corals, moss animals (bryozoans), lamp shells (brachiopods), chitons, snails, tusk shells (scaphopods), clams, sea urchins, and crabs; benthic marine foraminifers (shelled amoebas), land plants
Unnamed Marine Shale (Puente Formation)	High	--	Whales, lanternfishes, netdevils, blackchins, lightfishes, viperfishes, sanddabs, turbots, flounders, herrings, sardines, mackerels, sea basses/groupers, dreamers, fangtooths deep sea herring smelts, herrings, bristlemouths, sea urchin spines snails, clams, barnacles, starfishes, sea urchins, algal (seaweed) fronds, and sea stars and land plants (e.g., aspens, buckthorns, oaks, laurels)

Sources: Bedrossian et al. 2010; Saucedo et al. 2003; Yerkes et al. 2005
BP = before present; SVP = Society of Vertebrate Paleontology



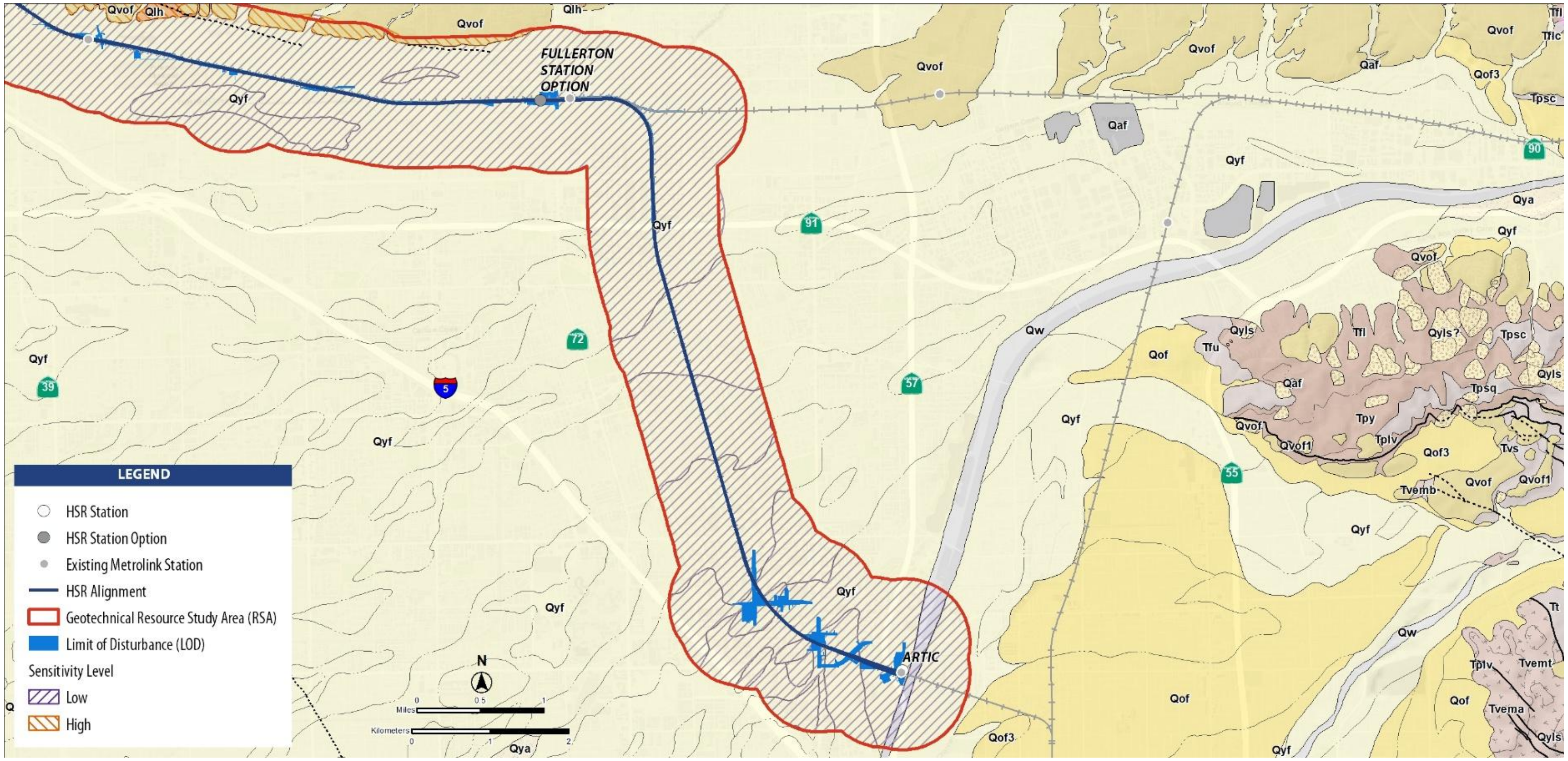
Sources: Authority 2025a; Bedrossian et al. 2010; Saucedo et al. 2003; Yerkes et al. 2005

Figure 3.9-8 Paleontologically Sensitive Materials in the Resource Study Area, Sheet 1 of 3



Sources: Authority 2025a; Bedrossian et al. 2010; Saucedo et al. 2003; Yerkes et al. 2005

Figure 3.9-8 Paleontologically Sensitive Materials in the Resource Study Area, Sheet 2 of 3



Sources: Authority 2025a; Bedrossian et al. 2010; Saucedo et al. 2003; Yerkes et al. 2005

Figure 3.9-8 Paleontologically Sensitive Materials in the Resource Study Area, Sheet 3 of 3

Wash Deposits

Recent wash deposits in active river channels in the RSA have not yielded paleontological resources. These deposits are too young to contain fossil remains, which are usually preserved in sediments older than 5,000 years before present. The wash deposits are classified as having low paleontological sensitivity.

Younger Alluvium

The younger alluvium is regarded as having a high paleontological sensitivity at depths of at least 6 feet below the natural ground surface. However, the younger alluvium is considered to be only of low paleontological sensitivity at depths fewer than 6 feet below the natural ground surface. Notable discoveries from this geologic unit are detailed in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

Fossil remains associated with younger alluvium are scientifically highly important because they document the late Pleistocene to middle Holocene age and nonmarine origin of the younger alluvium. Moreover, such remains are comparatively rare in the fossil record. These fossil occurrences also indicate a high potential for additional similar remains to be encountered by project-related earthmoving activities, even at depths only 6 feet below the current ground surface. For these reasons, the younger alluvium is regarded as paleontologically highly sensitive at depths at least 6 feet below the current ground surface. On the other hand, at shallower depths, a lower potential exists for such activities to encounter remains old enough to be considered a paleontological resource. Therefore, the younger alluvium is considered to have low paleontological sensitivity at depths less than 6 feet below current grade.

Older Alluvium

The older alluvium is classified as highly sensitive for paleontological resources. Fossil discoveries from the older alluvium indicate a high sensitivity for additional similar remains to be encountered at comparatively shallow depths below the natural ground surface.

The older alluvium has yielded late Pleistocene fossil remains at a number of fossil sites in the vicinity of the RSA, particularly in the downtown Los Angeles/Hollywood area, where numerous fossil sites occur west of the project section. Notable discoveries from this geologic unit are detailed in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

The fossil remains from this geologic unit are scientifically valuable because they document the late Pleistocene age and nonmarine origin of the older alluvium. The fossil occurrences also indicate a high potential for additional similar remains to be encountered by earthmoving activities in the RSA. The areas of high potential include areas immediately underlain by younger alluvium where project-related earthmoving activities would encounter the underlying older alluvium at comparatively shallow depths below the current ground surface. For these reasons, the older alluvium is regarded as having a high paleontological sensitivity.

Fernando Formation, Repetto Member

The Repetto Member of the Fernando Formation has yielded scientifically significant fossilized remains and is classified as having a high sensitivity for paleontological resources. Notable discoveries from this geologic unit are detailed in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

The fossil remains from this geologic unit are scientifically important because they document the Pliocene age and deep-marine origin of the Repetto Member. The fossil occurrences also indicate a high potential for additional similar remains to be encountered by earthmoving activities in the RSA. The areas of high potential include areas immediately underlain by younger alluvium where project-related earthmoving activities would encounter the underlying Repetto Member at comparatively shallow depths below the current ground surface. For these reasons, the Repetto Member is regarded as having a high paleontological sensitivity.

Unnamed Marine Shale (Puente Formation)

This unnamed marine shale has yielded scientifically significant fossil remains and is classified as having a high sensitivity for paleontological resources. Notable discoveries from this geologic unit are detailed in the *Los Angeles to Anaheim Project Section Paleontological Resources Technical Report* (Authority 2025b).

These fossil remains are scientifically important because they document the late Miocene to early Pliocene age and deep-water marine origin of the unnamed marine shale. Moreover, many of the species represented by the remains are extremely rare in the fossil record. These fossil occurrences also indicate a high potential for additional similar remains to be encountered by earthmoving activities in the RSA. The areas of high potential include areas immediately underlain by younger alluvium where project-related earthmoving activities would encounter the underlying unnamed marine shale at comparatively shallow depths below the current ground surface. Moreover, it is possible that some of the occurrences might represent the first known fossil records of their respective taxonomic groups. For these reasons, the unnamed marine shale is regarded as having a high paleontological sensitivity.

Geologic Units Underlying the Los Angeles to Anaheim Project Section

The northern portion of the project section trends from its northern terminus at U.S. Highway 101 southward for approximately 2.5 miles parallel to the western margin of the concrete-lined embankment of the Los Angeles River channel. This portion of the project section is underlain by Holocene and older Pleistocene age floodplain deposits of the ancient Los Angeles River (i.e., prior to channelization of the present-day river). The project section would cross the Los Angeles River by planned viaduct over a narrow width of floodplain deposits on the east side of the Los Angeles River.

The Metrolink stations at Commerce and Buena Park and the HSR station option at Fullerton would be at grade, and the Norwalk/Santa Fe Springs HSR station option would be elevated. The sediments underlying the station locations at Commerce and Norwalk are older alluvial fan deposits of late to middle Pleistocene age, which are exposed at the ground surface. Work at these stations may expose fossils at shallow depths in undisturbed sediments. The geologic unit underlying the Buena Park and Norwalk Stations is younger alluvium, which has high paleontological sensitivity at depths greater than 6 feet.

From Fullerton Junction to ARTIC, the project would remain at-grade. After Fullerton Junction, railroad right-of-way ownership transitions to Orange County Transportation Authority. The southern portion of the project section from the Orange County boundary line (Station SA 1050+00) to the Anaheim terminus at ARTIC is underlain primarily by Holocene alluvial fan and floodplain deposits. Similar to the northern and central portions, unmapped and undocumented artificial fill materials are anticipated to underlie some areas of the southern portion. Holocene alluvial deposits underlying the southern portion of the project section consist of generally unconsolidated sand, silt, and clay, with some gravel and cobbles.

The sediments underlying the proposed maintenance facilities are younger alluvium at the surface, which has high paleontological sensitivity at depths greater than 6 feet.

3.9.6 Environmental Consequences

3.9.6.1 Overview

This section discusses the impacts on GSSPR that would result from implementing the Shared Passenger Track Alternatives and station options during both construction and operations. Each resource category addresses potential impacts from the No Project Alternative and the Shared Passenger Track Alternatives. For GSSPR, any differences in the impacts for the HSR station options are described in the analysis.

This section also summarizes potential effects on fuel, mineral, and geothermal resources. Project features, including IAMFs, design standards, and compliance with the Authority's project design guidelines and technical memoranda, will avoid or minimize direct and indirect project effects resulting from geologic, soils, and seismic hazards. The Authority will prepare a CMP to manage geologic hazards during design and construction (**GEO-IAMF#1**). It will also monitor for slope instability (**GEO-IAMF#2**), monitor for subsurface gas (in-situ gas) (**GEO-IAMF#3**), install seismic early warning systems (**GEO-IAMF#6**), design for earthquake loads, use motion sensors to shut down operations during or after an earthquake (**GEO-IAMF#8**), implement track inspection systems, and apply appropriate guidelines and codes for design (**GEO-IAMF#10**). These project features reduce exposure of people or structures to effects, including the risk of loss, injury, or death. The Shared Passenger Track Alternatives are not expected to result in the loss or substantial reduction in availability of known mineral, fossil fuel, or geothermal resources because either the resource does not exist in the vicinity of the project (geothermal resources) or the Shared Passenger Track Alternatives do not substantially affect availability of resources by directly traversing the resource areas or by restricting access to resources (minerals and fossil fuel) in adjacent areas.

The Shared Passenger Track Alternatives and station options would result in direct impacts on paleontological resources, including the potential to destroy scientifically important fossils during ground disturbance in geologic units identified as having high or undetermined paleontological potential. The Authority will engage a qualified PRS (**GEO-IAMF#11**) to review final design for the CP and evaluate portions that would involve work in paleontologically sensitive units (either at the surface or in the subsurface). The PRS will also prepare and implement a PRMMP (**GEO-IAMF#13**) that describes when and where construction monitoring would be required; emergency discovery procedures; sampling and data-recovery procedures; procedures for the preparation, identification, analysis, and curation of fossil specimens and data recovered; and procedures for reporting. The Authority will provide WEAP training (**GEO-IAMF#14**) for project personnel. The Authority will establish procedures to monitor and halt construction when paleontological resources are found (**GEO-IAMF#15**).

The impacts of the Shared Passenger Track Alternatives are described and organized as follows.

Construction Impacts

- Impact GSSPR-1: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Construction
- Impact GSSPR-2: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction During Construction
- Impact GSSPR-3: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Construction
- Impact GSSPR-4: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Hazards Associated with Unstable Soils, Cut-and-Fill Slopes, or Collapsible Soils, Including Seismically Induced Landslides During Construction
- Impact GSSPR-5: Soil Erosion as a Result of Construction
- Impact GSSPR-6: Be Located on 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 During Construction
- Impact GSSPR-7: Difficult Excavation Encountered During Construction
- Impact GSSPR-8: Soil Corrosion and Expansion Hazards as a Result of Construction
- Impact GSSPR-9: Loss of Availability of Mineral or Energy Resources as a Result of Construction

- Impact GSSPR-10: Substantial Risk Caused by Disruption of Subsurface Oil and Gas Resources as a Result of Construction
- Impact GSSPR-11: Geologic Units Sensitive for Paleontological Resources Disturbed During Construction

Operational Impacts

- Impact GSSPR-12: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Operation
- Impact GSSPR-13: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction and Other Types of Seismically Induced Ground Failure During Operation
- Impact GSSPR-14: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Operation
- Impact GSSPR-15: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Associated with Unstable Soils, Cut-and-Fill Slopes, or Landslides, Including Seismically Induced Landslides

3.9.6.2 No Project Alternative

Under the No Project Alternative, the Shared Passenger Track Alternatives would not be built. Within the RSA, other planned and committed projects would be built over the planning horizon for HSR, which is 2040. The No Project Alternative would include the future development reported in the general plans of the cities and counties crossed by the Shared Passenger Track Alternatives, including both suburban expansion and development in existing urban areas. Section 3.19 identifies a number of proposed projects including bridge replacement, highway expansion, grade separation, and utility improvement projects that could result in effects similar to those of the project.

If the project is not built in the RSA, then temporary and permanent construction impacts and permanent changes from operations would be avoided. Under the No Project Alternative recent development trends are anticipated to continue, leading to impacts on GSSPR. Infrastructure and development that could occur with the No Project Alternative would experience geologic constraints or hazards associated with the varying degrees of expansiveness, corrosiveness, collapsibility, and settlement that soils in the RSA exhibit (refer to Section 3.9.5, Affected Environment). Additional effects involve geologic hazards from steep slopes near rivers and streams, primary seismic hazards from earthquake ground shaking, and secondary hazards from earthquake-induced liquefaction and slope failures. Historical trends in development have increased impermeable surfaces and ongoing development resulted in erosion and the loss of valuable topsoil in areas of Orange and Los Angeles Counties, including the RSA. In addition, the area has a history of land subsidence in response to water and mineral (oil and gas resources) extraction. As discussed in Section 3.9.5, the ground surface elevation in Los Angeles and Orange Counties has revealed a net decline of 0.5 inch per year near Santa Ana between 1993 and 1999, which happened to coincide with a net withdrawal of groundwater from the basin (Bawden et al. 2001, 2003). However, subsidence caused by changes in groundwater conditions in the Orange County Groundwater Basin is reported to be variable and does not indicate a pattern of widespread irreversible permanent lowering of the ground surface (Woodside and Westropp 2015). The most recent InSAR dataset for the period of July 2018 to July 2023 indicates no substantial change (less than 0.1 foot) for the groundwater basins in the Orange County Coastal Plain Basins (DWR 2023). Within the Orange County Water District Management area, which includes the area between Buena Park and ARTIC, Orange County Water District reports that there is no evidence of continuing irreversible land subsidence, nor is there evidence that land subsidence has interfered with surface uses (OCWD et al. 2022). The Orange County Water District report concludes that there is little potential for future widespread permanent, irreversible subsidence given Orange County Water District's commitment to sustainable groundwater management and policy of maintaining groundwater storage levels within a specified operating range (OCWD et al. 2022).

The infrastructure and development projects anticipated under the No Project Alternative could increase risks to public safety and potential for property damage caused by geology, soils, and seismicity by placing structures or people to reside or work in areas that are less geologically stable. Risks to infrastructure and developments include localized deposits of soils that have expansive, corrosive, collapsible qualities or exhibit excessive settlement under load. Additional risks involve primary seismic hazards from earthquake ground shaking, and secondary hazards from earthquake-induced liquefaction and potential lateral flows near river and creek crossings. Infrastructure and development projects anticipated under the No Project Alternative could affect geology and soils. Changes in local conditions from project implementation include water or wind erosion, loss of valuable topsoil, or constraints on the potential for oil and gas resource development. Infrastructure and development projects would not affect seismicity. The increasing population would result in development in areas where the risk of geologic and seismic hazards, such as slope instability near rivers or liquefaction in areas of liquefiable soils, is higher, ultimately resulting in more risk to the public and a greater chance of property damage. In addition, the continued use of older buildings to accommodate the increasing population could present a risk during a seismic event, because these buildings were typically built to less-stringent standards.

Future development projects would be required to be built in accordance with governing building and grading codes. However, the increasing population could result in new development occurring in less suitable areas as suburban expansion occurs and, as noted above, the increased habitation of older buildings, where the risk of geologic and seismic hazards such as ground shaking, slope instability near rivers, or liquefaction in areas of liquefiable soils is higher than in existing developed areas. Ultimately, this would result in more risk to the public and a greater chance of property damage. Future developments planned under the No Project Alternative would require individual environmental review, such as permits, regulatory requirements, and design standards. Future projects would need to comply with Title 24 California Building Standards Code requirements with adherence to geotechnical and stability regulations and would be designed to avoid or minimize effects.

Continued growth in the Los Angeles County and Orange County regions with accompanying construction of other projects, such as housing, business buildings, and highways, could affect paleontological resources. Following existing regulations would protect the great majority of these resources but, inevitably, some fossil resources could be lost.

3.9.6.3 Project Impacts

Construction and operations of the Shared Passenger Track Alternatives could result in temporary and permanent impacts related to geology, soils, and seismicity. Construction would involve, for example, demolition of existing structures, clearing and grubbing; handling, storing, hauling, excavating, and placing fill; possible pile driving; and construction of aerial structures, bridges, track, light maintenance facility (LMF), traction power substations, road modifications, utility upgrades and relocations, HSR electrical systems, and railbeds. Construction activities are described in Chapter 2, Alternatives. Project construction and operations could also result in temporary and permanent direct and indirect effects on paleontological resources.

Project operation would include the operation of trains and inspection and maintenance along the track and at LMFs and railroad right-of-way, as well as on the structures, fencing, power system, train control, electric interconnection facilities, rail yard facilities, and communications. Construction and operations and maintenance are more fully described in Chapter 2.

Impacts are categorized into three types:

- **Temporary Construction Impacts:** These are typical impacts that could occur during construction such as potential for landslides, subsidence, seismic impacts on construction personnel and equipment and adjacent infrastructure, difficult excavation, and reduction of mineral resources.

- **Permanent Construction Impacts:** These impacts relate to infrastructure or improvements built during construction (i.e., as a result of construction) that expose people or structures to geologic hazards or regional seismic activity.
- **Permanent Operational Impacts:** These impacts result from the potential of equipment, people, or goods using the Shared Passenger Track Alternatives to exacerbate existing geologic hazards during operation, as well as any impacts resulting from operational activities.

The following sections separately describe each construction and operational impact for the Shared Passenger Track Alternatives.

Construction Impacts

Impact GSSPR-1: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Construction

Shared Passenger Track Alternative A

Shared Passenger Track Alternative A would not include the types of construction that could potentially result in induced seismic faulting, extracting substantial groundwater, or creating unstable seismic conditions or stresses in the Earth's crust. It would neither increase the potential for seismic ground shaking to occur nor increase the potential exposure of people or structures to associated risks (Authority 2025a).

In addition, there are no known active faults with documented Holocene-age fault ruptures that traverse the project footprint and alignment (refer to Figure 3.9-4). However, the PHT fault underlies the alignment at depth, and the up-dip termination of the fault is approximately 1.5 miles beneath the alignment. Although this is not a ground rupture hazard, active folding in Holocene-age alluvium has been reported near the PHT fault's Santa Fe Segment (Leon et al. 2007). Therefore, there is a potential hazard from tectonic uplift and tilting during a potential future large-magnitude earthquake on the PHT fault. This condition would not be exacerbated by project construction; consequently, there would be no increased exposure of people or structures to loss of life, injuries, or destruction in relation to surface fault rupture during construction.

Therefore, Shared Passenger Track Alternative A would not increase exposure of people or structures to potential loss of life, injuries, or destruction from surface fault rupture or ground shaking during construction caused by exacerbation of existing geologic hazards.

Shared Passenger Track Alternative B

Shared Passenger Track Alternative B would not include the types of construction that could potentially result in induced seismic faulting or seismically induced ground shaking. The 15th Street LMF site is not in an Alquist-Priolo Earthquake Fault Zone, and no known active faults project toward the site. The nearest mapped active faults with displacement of Holocene-age deposits are the Hollywood fault and Newport-Inglewood fault, approximately 7 miles north and 7.5 miles west, respectively, from the 15th Street LMF site. However, as with Shared Passenger Track Alternative A, there is a potential hazard from tectonic uplift and tilting during a possible future large-magnitude earthquake on the PHT fault. This condition would not be exacerbated by project construction; consequently, there would be no increased exposure of people or structures to loss of life, injuries, or destruction in relation to surface fault rupture during construction. Therefore, Shared Passenger Track Alternative B would not increase exposure of people or structures to potential loss of life, injuries, or destruction from surface fault rupture or ground shaking during construction caused by exacerbation of existing hazards.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives and would be the same distance from the nearest mapped faults. The types of construction activities would be the same as for the Shared Passenger Track Alternatives. Construction of the Norwalk/Santa Fe Springs HSR Station Option would not directly or indirectly increase exposure of people or structures to potential loss of life, injuries, or destruction from surface fault rupture or seismically induced ground shaking caused by exacerbation of existing seismic hazards.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur within a larger area than would be modified under the Shared Passenger Track Alternatives, and the HSR station platform would be slightly closer to the up-dip termination of the PHT fault to the west. However, the potential hazard presented would not be exacerbated by construction of the Fullerton HSR Station Option. The overall distance is similar and the types of construction activities would be the same as for the Shared Passenger Track Alternatives. Construction of the Fullerton HSR Station Option would not directly or indirectly increase exposure of people or structures to potential loss of life, injuries, or destruction from surface fault rupture or seismically induced ground shaking caused by the exacerbation of existing seismic hazards.

CEQA Conclusion

The impact under CEQA from surface fault rupture or seismically induced ground shaking during construction would be less than significant. Construction of the Shared Passenger Track Alternatives would not cause or exacerbate the potential for surface fault rupture or ground shaking. It would therefore not increase the potential to expose people or structures to potential loss of life, injuries, or destruction. Therefore, CEQA does not require mitigation.

Impact GSSPR-2: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction During Construction

Shared Passenger Track Alternative A

Seismically induced ground failures encompass a range of secondary hazards; below is a discussion of those that are applicable to liquefaction. Refer to Impact GSSPR-4 for a discussion of additional conditions such as landslides, unstable soils, and slopes.

Liquefiable soils tend to decrease in volume when subjected to ground shaking during earthquakes. The State of California Seismic Hazard Zone Maps delineate areas as being susceptible to liquefaction if past occurrence of liquefaction was reported or local geological, geotechnical, and groundwater conditions suggest a potential for liquefaction exists. Approximately 13 miles of the project alignment falls within the liquefaction hazard zone (refer to Figure 3.9-5).

Temporary structures, such as shoring and scaffoldings, may be subject to moderate to strong ground shaking during construction and thereby potential liquefaction hazards and subsequent settlement. However, structures erected for the sole purpose of construction would be designed to be consistent with Caltrans seismic design criteria (Caltrans 2019) or equivalent standards (**GEO-IAMF#7**). In addition, as previously described, **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required. Although **GEO-IAMF#7** is focused on facility design, compliance with these required regulations also protects against the loss of life and injuries through provisions for human safety. It also requires construction to account for geotechnical properties and thus address risk factors associated with secondary seismic hazards.

Furthermore, construction activities would not cause a regional increase in groundwater elevations or other geologic conditions that would directly or indirectly cause or accelerate the potential for liquefaction. Any activities that create a local fluctuation of groundwater, such as temporary dewatering for construction activities that may occur during trenching, would also conform to guidelines specified by relevant transportation and building agencies and codes (**GEO-IAMF#10**).

Therefore, Shared Passenger Track Alternative A would not increase exposure of people or structures to potential loss of life, injuries, or destruction from liquefaction during construction.

Shared Passenger Track Alternative B

With the LMF at 15th Street, secondary seismic hazards during construction would be similar to those described for Shared Passenger Track Alternative A, with the exception that a portion of the 15th Street LMF is within a CGS-delineated liquefaction zone. As discussed above, construction activities would not cause a regional increase in groundwater elevations or other geologic conditions that would directly or indirectly cause or accelerate the potential for liquefaction during construction. Furthermore, any temporary local fluctuations that may occur in relation to trenching or other construction activities would adhere to relevant transportation and building agencies and codes. **GEO-IAMF#7** and **GEO-IAMF#10** include implementing current Caltrans seismic design criteria for temporary construction structures and compliance with applicable regulations and codes. With **GEO-IAMF#7** and **GEO-IAMF#10**, Shared Passenger Track Alternative B would not increase exposure of people or structures to potential loss of life, injuries, or destruction from liquefaction during construction.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts from liquefaction would be the same as those of the Shared Passenger Track Alternatives in the station area, because construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives, and would use the same types of construction activities. If structures intended for construction are in place long enough, the governing codes of the Caltrans seismic design criteria (Caltrans 2019) or their equivalent would be incorporated (**GEO-IAMF#7**), and construction activities would be conducted in accordance with all pertinent regulations and codes (**GEO-IAMF#10**). With **GEO-IAMF#7** and **GEO-IAMF#10**, the HSR station option would not increase exposure of people or structures to potential loss of life, injuries, or destruction from liquefaction during construction.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts from liquefaction would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives, which is within the CGS-delineated liquefaction zone. The types of construction activities would be the same. If structures intended for construction are in place long enough, the governing codes of the Caltrans seismic design criteria would be incorporated (**GEO-IAMF#7**) or equivalent standards, and construction activities would be conducted in accordance with all pertinent regulations and codes (**GEO-IAMF#10**). With **GEO-IAMF#7** and **GEO-IAMF#10**, the HSR station option would not increase exposure of people or structures to potential loss of life, injuries, or destruction from liquefaction during construction.

CEQA Conclusion

The impact under CEQA related to liquefaction during project construction would be less than significant. **GEO-IAMF#7** and **GEO-IAMF#10**, which are part of the project design, include effective practices to avoid directly or indirectly causing substantial adverse effects, such as an increase in risk to personal injury, loss of life, or destruction of property from project construction that are associated with liquefaction. This includes implementation of the current HSR Design Criteria Manual and Caltrans seismic design criteria and adherence to applicable regulations and codes. With **GEO-IAMF#7** and **GEO-IAMF#10**, the Shared Passenger Track Alternatives would not increase exposure of people or structures to potential loss of life, injuries, or destruction from liquefaction during construction. Therefore, CEQA does not require mitigation.

Impact GSSPR-3: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Construction

Shared Passenger Track Alternative A

Shared Passenger Track Alternative A would not include the types of construction that could potentially result in induced seismic induced flooding or dam failure; however, portions of the project footprint are within flood inundation zones. Specifically, portions of the project footprint are within the flood inundation zones of Hansen Dam, Garvey Reservoir, Whittier Narrows Dam, Brea Dam, Fullerton Dam, Carbon Canyon Dam, and Prado Dam (refer to Figure 3.9-6). The risk of exposure to flooding from dam failure during construction is no greater than under existing conditions and would not increase the exposure of people or structures to potential loss of life, injury, or destruction beyond what they are currently exposed to in the resource hazards RSA. Construction activities would also not exacerbate dam failure because construction would not be near dams or reservoirs.

Seiche hazard was evaluated based on the potential for a seiche to inundate any portion of the project section during construction. Although large flood-control reservoirs are upgradient of the project section, the risk of damage from seiches during construction is considered low because construction would not be near these reservoirs.

Therefore, Shared Passenger Track Alternative A would not increase exposure of people or structures to potential loss of life, injuries, or destruction from seismically induced flooding caused by dam failure or seiche during construction.

Shared Passenger Track Alternative B

With the LMF at 15th Street, the risk of exposure to seismically induced flooding from dam failure during construction would be the same as that described for Shared Passenger Track Alternative A. Shared Passenger Track Alternative B would traverse the same urban areas as Shared Passenger Track Alternative A and is in the same flood inundation zones depicted on Figure 3.9-6. The risk of exposure to flooding from dam failure during construction is no greater than under existing conditions and would not increase the exposure of people or structures to potential loss of life, injury, or destruction beyond what they are currently exposed to in the resource hazards RSA. Construction activities would also not exacerbate dam failure because construction would not be near dams or reservoirs. Consequently, Shared Passenger Track Alternative B would not increase exposure of people or structures to potential loss of life, injuries, or destruction from seismically induced flooding caused by dam failure or seiche during construction.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, the risk of exposure to seismically induced flooding from dam failure during construction would be the same as that of the Shared Passenger Track Alternatives in the station area. Flood-control reservoirs are upgradient of the station; however, the risk of damage from flooding caused by dam failure or seiches is considered low because construction would not be near flood-control reservoirs. Consequently, the HSR station option would not increase exposure of people or structures to potential loss of life, injuries, or destruction from seismically induced flooding caused by dam failure or seiche during construction.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives, but it is within the same area of dam inundation (refer to Figure 3.9-6). Flood-control reservoirs are upgradient of the station, yet the risk of damage caused by flooding from dam failure or seiches is considered low because construction would not be near flood-control reservoirs. Consequently, the HSR station option would not increase exposure of people or structures to potential loss of life, injuries, or destruction from seismically induced flooding caused by dam failure or seiche during construction.

CEQA Conclusion

The impact under CEQA related to seismically induced flooding during project construction would be less than significant. Construction activities would not exacerbate dam failure because construction would not be near dams or reservoirs. Therefore, the impact would be less than significant, and CEQA does not require mitigation.

Impact GSSPR-4: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Hazards Associated with Unstable Soils, Cut-and-Fill Slopes, or Collapsible Soils, Including Seismically Induced Landslides During Construction

Shared Passenger Track Alternative A

Unstable soils consist of loose or soft deposits of sands, silts, and clays that are not adequate to support planned structure loads. These soils exhibit low shear strength and, when loaded, can fail through bearing failures or slope instabilities, presenting a risk to personal safety and property. Failure can result in temporary effects during construction. Although relatively competent soils underlie the project footprint at shallow depths beneath the ground surface in the RSA, there are some areas underlain by unstable soils.

Any cut-and-fill slopes that may be planned are anticipated to be less than 20 feet in height. Temporary cut slopes made during construction excavation would be sloped at appropriate angles based on the shear strength parameters of the earth materials at the locations of planned excavations.

Potentially collapsible soils may be present at localized areas along the project section; the potential for these to occur is low to moderate in each city along the project section. The effect of collapsible soils could endanger temporary construction structures, equipment, and employees throughout project construction.

Shared Passenger Track Alternative A will conform to guidelines specified by relevant transportation and building agencies that require the Authority to account for soil properties during project design and construction and thus address risk factors associated with bearing capacity, slope stability, and collapsible soils (**GEO-IAMF#10**). As previously described, **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required. Adherence to these codes and regulations requires that construction activities account for soil properties to protect from the loss of life, structures, injury, or destruction during construction.

Additionally, earthwork, including construction of cut-and-fill slopes, will be designed and conducted in accordance with relevant requirements of Section 19 of the most current Caltrans Standard Specifications (Caltrans 2023). Provided that earthwork is performed in accordance with appropriate geotechnical recommendations, there would be no effect during construction from slope failures associated with cut-and-fill slopes.

Landslide hazard has been evaluated along the project section for areas based on currently available geologic data, including the State of California Seismic Hazard Maps. The Seismic Hazard Maps delineate areas where previous occurrences of landslide movement have been reported or where local topographic, geological, geotechnical, and subsurface water conditions suggest there is landslide potential. The project would not cross any mapped landslide boundaries indicated on published geologic maps. The nearest seismically induced landslide zones mapped by CGS are approximately 1,000 feet east of the project footprint, east of the Los Angeles River, near downtown Los Angeles, based on the Seismic Hazard Maps quadrangles.

Moreover, although the effects of soil failure would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of these temporary activities relative to the infrequency of large earthquakes.

Therefore, construction of Shared Passenger Track Alternative A would not increase the risk of exposing people or structures to potential loss of life or structures, injury, or destruction from slope failure hazards associated with unstable soils, cut-and-fill slopes, collapsible soils, or landslides.

Shared Passenger Track Alternative B

With the LMF at 15th Street, slope failure hazards during construction would be similar to those described for Shared Passenger Track Alternative A. Temporary slopes would be built with an adequate factor of safety to avoid slope failures and sloped at appropriate angles based on the shear strength parameters of the earth materials at the locations of planned excavations. The project section would not cross any mapped landslide boundaries indicated on published geologic maps. In addition, potentially collapsible soils may be present at localized areas along the project section; the potential for these to occur is low to moderate in each city along the project section. The effect of collapsible soils could endanger temporary construction structures, equipment, and employees throughout project construction. The project would be designed as required by the codes and regulations outlined in **GEO-IAMF#10**. Lastly, although the effects of soil failure would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of these temporary activities relative to the infrequency of large earthquakes. Therefore, construction of Shared Passenger Track Alternative B would not increase the risk of exposing people or structures to potential loss of life or structures, injury, or destruction from slope failure hazards associated with unstable soils, cut-and-fill slopes, collapsible soils, or landslides.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area, because construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives, which does not cross any mapped landslide boundaries. The types of construction activities would be the same, with no cut-and-fill slopes; however, in areas of potentially collapsible soils, incorporation of the guidelines and standards outlined in **GEO-IAMF#10** would reduce risks associated with collapsible soils. Construction of the Norwalk/Santa Fe Springs HSR Station Option would not increase the risk of exposing people or structures to potential loss of life or structures, injury, or destruction caused by slope failure hazards associated with unstable soils, cut-and-fill slopes, or collapsible soils, including seismically induced landslides during construction.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives but would not cross any mapped landslide boundaries. The types of construction activities would be the same, with no cut-and-fill slopes; however, in areas of potentially collapsible soils, incorporation of the guidelines and standards outlined in **GEO-IAMF#10** would reduce risks associated with collapsible soils. Construction of the Fullerton HSR Station Option would not increase the risk of exposing people or structures to potential loss of life, injury, or destruction from slope failure hazards associated with unstable soils, cut-and-fill slopes, or collapsible soils, including seismically induced landslides during construction.

CEQA Conclusion

The impact under CEQA related to slope failure hazards during project construction would be less than significant. **GEO-IAMF#10** includes adherence to applicable regulations and codes to avoid the risk of exposing people or structures to increased potential of the loss of life or structures, injury, or destruction from slope failure hazards associated with unstable soils, cut-and-fill slopes, or collapsible soils, including seismically induced landslides during construction. Therefore, CEQA does not require mitigation.

Impact GSSPR-5: Soil Erosion as a Result of Construction

Shared Passenger Track Alternative A

Construction of Shared Passenger Track Alternative A including facilities such as the HSR station at ARTIC, relocation of the Commerce and Buena Park Metrolink stations, the 26th Street LMF, freight yard improvements, and grade separations would require excavation and grading activities that would result in removal of vegetation and paved surfaces in the RSA. This loss of protective cover would increase the potential for surface water runoff and expose unprotected soils to wind and water erosion. Temporary, impermeable work surfaces created during construction would also result in increased surface water runoff, exposing unprotected soils present in the RSA to water erosion. If exposed soils are not protected from wind or water erosion, such as when vegetation is cleared for work areas and material stockpiles, both the exposed work areas and stockpiles would erode and cause indirect effects on air and water quality.

The impact of soil erosion was evaluated based on the presence of potentially erosive conditions within the RSA. Potentially erosive conditions are identified as areas having a combination of potentially erosive soils and uncovered slopes. The majority of the RSA traverses an area of low relief and is generally covered with impermeable surfaces that protect underlying soils against erosion. There is no agricultural land, and natural and seminatural vegetation communities are uncommon within the RSA and are most often found in association with aquatic features such as rivers, built watercourses, and basins; refer to the vegetation communities and land cover types discussions in Section 3.7.5, Affected Environment, in Section 3.7; and Section 3.14.5.2, Important and Protected Farmland, in Section 3.14, Agricultural Farmland and Forest Land. However, soils that are highly erodible have been identified along portions of the project section, based on NRCS soil data. Areas of potentially erodible soils will be evaluated during site-specific geotechnical and engineering geologic studies during project design and prior to project implementation.

Accelerated soil erosion could occur as a result of project construction. The potential for more surface water runoff exists during construction when existing vegetation is removed, which increases the likelihood for unprotected soils to be exposed to both wind and water erosion. Increased surface water runoff would also result from demolition of existing buildings or construction of temporary, impermeable work surfaces. The effects caused by the potential presence of erodible soils will be remediated during construction. Several methods could be carried out for controlling water and wind erosion of soils. These include the use of mulches, revegetation, and covering of areas with geotextiles. These methods will be incorporated into the project as appropriate and in coordination with other erosion, sediment, stormwater management, and fugitive dust control.

The project design addresses water and wind erosion through incorporating BMPs, including revegetation, and covering areas with geotextiles, along with using riprap and check dams (**GEO-IAMF#1** and **HYD-IAMF#3**).

As previously described, project design and construction will also conform to guidelines specified by relevant transportation and building agencies and codes to build the HSR system in accordance with the best available practices (**GEO-IAMF#10**). These guidelines provide guidance on:

- Minimization of water and wind erosion
- Characterization of soils and geotechnical conditions at sites
- Principles, data, specifications, plans, and economics pertaining to the engineering, design, and construction of railways
- Construction requirements relating to structural safety
- Minimum design and construction standards for each aspect of transportation system design

Because these practices require the Authority to take soil properties into account, these practices reduce effects associated with wind and water erosion during construction.

Construction of Shared Passenger Track Alternative A in areas of high groundwater could require dewatering for bridge column construction or construction of below-grade underpasses and the trench section near Fullerton Municipal Airport. If dewatering is necessary during construction, the amount of dewatering would likely be relatively small because depth of groundwater is generally below depth of excavation and would be conducted in widely spaced locations. The impact from groundwater dewatering would be direct and temporary because dewatering would cease once construction is completed. Dewatering will be conducted in compliance with the State Water Resources Control Board Storm Water Construction General Permit, which minimizes the potential for contaminants to be discharged into groundwater. Refer also to Section 3.8 for further discussion of dewatering.

Construction of Shared Passenger Track Alternative A would potentially remove vegetation and expose unprotected soil to the erosive forces of wind and water. However, most of the project section is in an existing railroad right-of-way in areas where little to no vegetation exists. The above-mentioned IAMFs, including standard construction practices and BMPs that account for soil properties during project design and construction, as well as development of a stormwater pollution prevention plan, will reduce these effects. These standard construction practices and BMPs would be effective in addressing temporary wind and water erosion potential from construction because they would provide a barrier between exposed soils and erosive forces.

Shared Passenger Track Alternative B

With the LMF at 15th Street, soil erosion during construction would be the same as those described for Shared Passenger Track Alternative A. As stated above, with incorporation of the same IAMFs as Shared Passenger Track Alternative A (**GEO-IAMF#1**, **GEO-IAMF#10**, and **HYD-IAMF#3**), the 15th Street LMF would not result in additional soil erosion from construction.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area, because construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives. As stated above, with incorporation of the same IAMFs as Shared Passenger Track Alternative A (**GEO-IAMF#1**, **GEO-IAMF#10**, and **HYD-IAMF#3**), there would be no additional impacts from soil erosion from construction.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be similar to those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives, which would increase the potential for soil erosion. As stated above, however, with incorporation of the same IAMFs as Shared Passenger Track Alternative A (**GEO-IAMF#1**, **GEO-IAMF#10**, and **HYD-IAMF#3**), there would be no additional impacts from soil erosion from construction.

CEQA Conclusion

The impact under CEQA related to soil erosion during project construction would be less than significant. **GEO-IAMF#1**, **GEO-IAMF#10**, and **HYD-IAMF#3**, which are part of the project design, include effective measures to avoid substantial soil erosion or loss of topsoil through incorporation of BMPs that account for soil properties and development of a stormwater pollution prevention plan. Therefore, CEQA does not require mitigation.

Impact GSSPR-6: Be Located on 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 During Construction

Shared Passenger Track Alternative A

Please refer to Impact GSSPR-2, Impact GSSPR-4, and GSSPR-5 discussions for construction impacts related to liquefaction, landslides, and collapsible soil.

Ground subsidence generally occurs in localized areas because of volume change from dewatering of peat, organic soils, or soft silts and clay or ongoing decomposition of organic-rich soils. Petroleum extraction can also create subsidence.

Ground subsidence is a time-dependent process, and the likelihood of ground subsidence during construction is considered low because of the comparatively short duration of construction (as opposed to operation). Although substantial oil extraction has occurred beneath portions of the project section, historical ground subsidence as a result of oil extraction in vicinity of the project section is limited to the Santa Fe Springs oil field, through which the alignment passes. In this oil field, a maximum differential subsidence of 0.66 meter (approximately 2.2 feet) was measured between 1926 and 1963 in a 16-square-kilometer area (Castle and Yerkes 1976). Secondary oil recovery through water injection began in the late 1950s in the Los Angeles Basin oil fields and was reported to have greatly reduced or halted the prior subsidence. The possibility exists that continued oil extraction may cause ground subsidence; however, techniques for controlling ground subsidence resulting from the extraction of oil have now been successfully applied in oil fields for several decades. These techniques include pumping water into the subsurface to replace the extracted oil and closely monitoring the ground surface elevation. Unless there is a substantial change in CalGEM or water agency policies regarding extraction procedures, there is minimal potential of large-scale land subsidence along the project section, and the likelihood of differential settlement is remote. Construction or modification of bridges, culverts, grade separations, open trench sections, and construction near surface water features (where groundwater levels may be locally higher) could require dewatering during construction. The amount of dewatering is likely to be relatively small and done in widely spaced locations. Effects from groundwater dewatering would be temporary because dewatering would cease once construction has been completed. Controlling the amount of groundwater withdrawal would counteract the potential for subsidence to occur (**GEO-IAMF#1**).

GEO-IAMF#1 will reduce the effects of dewatering by controlling and minimizing groundwater withdrawal and requiring treatment before discharge. Therefore, the project would not increase the potential for subsidence.

Groundwater extraction along the project section is limited in the Orange County Coastal Plain area. Some minor ground subsidence has been detected in the Orange County area with periods of subsequent ground surface rebound. Excavations for the planned structures would likely not exceed 10 feet in depth with the exception of underpasses, the trench at Fullerton Municipal Airport, and utilities, which could be up to 30 feet deep. Groundwater could be encountered within the deeper portion of the excavation. If some dewatering is necessary, it would not cause measurable subsidence.

The project alignment is relatively flat; therefore, the probability of lateral spreading in response to liquefaction of subsurface soil is low. However, there is a possibility that localized lateral spreading may occur in areas where the project alignment crosses over creeks and river channels, particularly if those areas are zoned to have potential for liquefaction.

Based on the generally flat topography along the alignment, the likelihood of lateral flow is low, except adjacent to river and creek banks where moderate to steep slopes exist. As discussed under Impact GSSPR-2, the potential effects of liquefaction will be reduced with **GEO-IAMF#7** and **GEO-IAMF#10**, which also address lateral spreading.

To reduce effects, construction structures, such as scaffolding, meeting the criteria of temporary structures would be designed in accordance with Caltrans seismic design criteria (Caltrans 2019) or equivalent standards (**GEO-IAMF#7**). In addition, as previously described, **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required.

Incorporation of **GEO-IAMF#7** and **GEO-IAMF#10** address risk factors associated with subsidence and lateral spreading.

Shared Passenger Track Alternative B

The effect of subsidence and lateral spread during construction of the LMF at 15th Street would be similar to that described for Shared Passenger Track Alternative A. As stated above, construction could require dewatering, but the amount of dewatering is likely to be relatively small and done in widely spaced locations. The project will incorporate the same IAMFs as for Shared Passenger Track A that will reduce the effects of dewatering by controlling and minimizing groundwater withdrawal and requiring treatment before discharge (**GEO-IAMF#1**). Although the potential for lateral spread is low, construction of the LMF at 15th Street will also include **GEO-IAMF#7** and **GEO-IAMF#10**. Therefore, the proposed LMF at 15th Street would not cause or accelerate the potential for ground subsidence or lateral spread during construction.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternative in the station area, because construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives. Although the potential for subsidence is low, **GEO-IAMF#1** will address subsidence during construction of the station improvements. The likelihood of lateral spread is low; however, construction will also include **GEO-IAMF#7** and **GEO-IAMF#10**, reducing any potential effects.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives but it is not in an area of recent surface subsidence. Although the potential for subsidence is low, **GEO-IAMF#1** will address subsidence during construction of the station improvements. The likelihood of lateral spread is also low; however, construction will also include **GEO-IAMF#7** and **GEO-IAMF#10**, reducing any potential effects.

CEQA Conclusion

The impact under CEQA related to subsidence and lateral spreading during project construction would be less than significant. Although the potential for subsidence is low, **GEO-IAMF#1**, which is part of the project design, will address subsidence during construction of the project components. The likelihood of lateral spread is also low; however, construction will also include **GEO-IAMF#7** and **GEO-IAMF#10**, which are also part of the project design, to reduce any potential effects. Therefore, the impact would be less than significant and CEQA does not require mitigation.

Impact GSSPR-7: Difficult Excavation Encountered During Construction

Shared Passenger Track Alternative A

Excavations that extend below groundwater levels could result in difficult excavations that could temporarily increase the risk of personal injury, loss of life, or property damage for construction personnel on construction-related property. Excavation at the Fullerton trench, planned to depths of approximately 30 feet below ground surface, is the only area in the project footprint where construction is anticipated to encounter groundwater. At these locations, hydrostatic pressures can result in instabilities of the excavation side-slopes or heave of the excavation base, leading to loss of ground support. These conditions can be encountered in localized areas such as at river crossings. These types of design issues are routinely handled during construction through the use of temporary dewatering with deep groundwater wells and well points that lower the water level; sheet pile walls systems to stabilize the soil; or techniques such as jet grouting and cement deep soil mixing techniques that add cement to the soil, thereby providing a cement-soil mix that resists hydrostatic forces. Alternatively, excavations can be avoided by using deep foundations that can be driven or drilled into the loose, water-saturated soil.

Earth materials within the RSA in general are expected to be easily rippable with modern earthmoving equipment in good working order. Localized zones of boulders may be present near river crossings, which could impede drilling progress for future foundation piles at elevated bridge crossings. Boulder-sized material may be encountered during foundation pile drilling. Specialized drilling equipment and cutting tools may be necessary to penetrate through boulders.

As previously described, the Authority will conform to guidelines specified by relevant transportation and building agencies and codes (**GEO-IAMF#10**), requiring the contractor to account for geotechnical properties during the construction phases of the project and thus address risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater. Shared Passenger Track Alternative A would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations.

Shared Passenger Track Alternative B

With the LMF at 15th Street, difficult excavation encountered during construction would be similar to that described for Shared Passenger Track Alternative A, with an additional area of construction that has the potential to encounter boulder zones. The 15th Street LMF is adjacent to the Los Angeles River, and the presence of cobbles and boulders should be anticipated, and construction may require specialized drilling equipment. With inclusion of **GEO-IAMF#10** and conformance to guidelines and codes specified by relevant transportation and building agencies, Shared Passenger Track Alternative B would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area, because construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives. The HSR station option area does not involve earthwork below groundwater levels and the types of construction methods would be the same as those used for the Shared Passenger Track Alternatives. Earth materials within the RSA in general are expected to be easily rippable with modern earthmoving equipment in good working order. With inclusion of **GEO-IAMF#10** and conformance to guidelines and codes specified by relevant transportation and building agencies, the HSR station option would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives but the types of construction methods would be the same as those used for the Shared Passenger Track Alternatives in the station area, and would not involve earthwork below groundwater levels. Earth materials within the RSA in general are expected to be easily rippable with modern earthmoving equipment in good working order. With inclusion of **GEO-IAMF#10** and conformance to guidelines and codes specified by relevant transportation and building agencies, the HSR station option would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations.

CEQA Conclusion

The impact under CEQA related to difficult excavation encountered during project construction would be less than significant. **GEO-IAMF#10**, which is part of project design, requires the contractor to account for geotechnical properties during project design and construction. Additionally, design and construction practices will address risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater. Project construction would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations. Therefore, CEQA does not require mitigation.

Impact GSSPR-8: Soil Corrosion and Expansion Hazards as a Result of Construction

Shared Passenger Track Alternative A

Corrosive soils have electrochemical or chemical properties that can corrode or weaken concrete or uncoated steel, which are principal components of Shared Passenger Track Alternative A. Corrosion, if not accounted for in the design of the project, can permanently weaken structures built on corrosive soils, potentially causing structural failure. Soils within the project footprint could exhibit corrosive characteristics, which could endanger equipment, temporary construction support structures, and employees throughout project construction.

Expansive soils respond to changes in soil moisture content by expanding when wet and contracting when dry. The more water they absorb, the more they increase in volume and, conversely, the more they decrease in volume when they dry out. Through this change in volume, expansive soils exert uplift or lateral pressures, thus providing unstable support for temporary construction support structures.

Moderately to highly expansive soils could be locally encountered along portions of the project section where it crosses older Pleistocene alluvial fan deposits and potential areas of undocumented fills. In addition, moderately to highly corrosive soils could be encountered along portions of the project section.

The project will address potential increases in the effects on people and structures related to corrosive and expansive soils by conforming to guidelines specified by relevant transportation and building agencies and codes (**GEO-IAMF#10**). As previously described, **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required. Adherence to these codes and regulations requires that construction activities account for soil properties to protect from the loss of life or structures, injury, or destruction during construction. Therefore, temporary increases to risks associated with the effects presented by corrosive or expansive soils would be reduced.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to corrosive and expansive soils during construction would be the same as those described for Shared Passenger Track Alternative A, because both LMF sites may be in areas that feature corrosive and expansive soils. Construction of the LMF will include **GEO-IAMF#10**. Therefore, as for Shared Passenger Track Alternative A, temporary risks associated with the effects presented by corrosive or expansive soils would be avoided.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives and encounter the same potentially corrosive and expansive soils. **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required. Adherence to these codes and regulations requires that construction activities account for soil properties to protect from the loss of life or structures, injury, or destruction during construction.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives but would encounter the same potentially corrosive and expansive soils. **GEO-IAMF#10** identifies a series of state and federal regulations and codes to which adherence is required. Adherence to these codes and regulations requires that construction activities account for soil properties to protect from the loss of life or structures, injury, or destruction during construction.

CEQA Conclusion

The impact under CEQA related to corrosive and expansive soils during project construction would be less than significant. **GEO-IAMF#10**, which is included as part of project design, will effectively address hazards during construction. Therefore, CEQA does not require mitigation.

Impact GSSPR-9: Availability of Mineral or Energy Resources as a Result of Construction

Shared Passenger Track Alternative A

Effects on mineral resources were evaluated based on the potential for the project including the HSR station at ARTIC, relocation of the Commerce and Buena Park Metrolink stations, the 26th Street LMF, and grade separations to affect the availability of mineral resources within the RSA. As discussed in Section 3.9.5.1, Geology, Soils, and Seismicity, the project section would traverse areas underlain by geologic materials such as sand and gravel that may be considered mineral resources and that could be used as construction materials. However, given that there is no mining of mineral resources within the RSA, project construction would not temporarily or permanently affect the availability of mineral resources.

As discussed in Section 3.9.5.1 and depicted on Figure 3.9-7, the project section would traverse areas underlain by fossil fuels. There are oil wells within 200 feet of the HSR track centerline (refer to Figure 3.9-7). The contractor will inspect these wells as required by **SS-IAMF#4** to assess their status. Abandoned wells will be re-abandoned in accordance with CalGEM standards and in coordination with the well owner to provide for safe abandonment. Active wells will be abandoned and relocated in accordance with CalGEM standards and in coordination with the well owner. In the case that relocated wells do not attain the current production rates of the now-abandoned active wells, the Authority will be responsible for compensating the well owner for lost production.

As discussed in Section 3.9.5.1, the project section would not cross areas of known geothermal resources. Accordingly, the Authority does not anticipate encountering existing geothermal wells or impeding future geothermal well development in any portion of the RSA. Therefore, project construction would not permanently affect the availability of geothermal resources.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to loss of availability of mineral or energy resources during construction would be the same as those described for Shared Passenger Track Alternative A. As discussed in Section 3.9.5.1 and depicted on Figure 3.9-7, there are oil wells within 200 feet of the HSR track centerline and the contractor will inspect wells as required by **SS-IAMF#4** to assess their status.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives, which, as indicated on Figure 3.9-7, has oil wells within 200 feet of the station site and is 0.75 mile from an oil field. The contractor will inspect wells as required by **SS-IAMF#4** to assess their status. There would be no additional impacts on mineral resources, oil wells, or geothermal resources.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives but would not have additional oil wells within 200 feet of the station site.

CEQA Conclusion

The impact under CEQA related to loss of availability of mineral or energy resources during project construction would be less than significant. **SS-IAMF#4** will effectively address risks such that project construction would not make a known petroleum or natural gas resource of regional or statewide value unavailable to extraction through the physical presence of the project either at the ground surface or subsurface. The Authority would compensate well owners to offset loss of productivity that might result from well relocation. Therefore, CEQA does not require mitigation.

Impact GSSPR-10: Substantial Risk Caused by Disruption of Subsurface Oil and Gas Resources During Construction

Shared Passenger Track Alternative A

The subsurface gas hazard was evaluated based on the likelihood of encountering an area of known or likely subsurface gas hazard such as methane within the RSA. In the northern and central portions, the RSA traverses three oil fields (refer to Figure 3.9-7), which have a high probability of containing methane and other subsurface gases. The potential for encountering subsurface gases is considered high where foundation piles would be drilled, including for elevated structures in the oil fields, as would be planned for the viaducts within the Bandini and Santa Fe Springs oil fields. The contractor will conform to guidelines specified by federal and state Occupational Safety and Health Administration regulatory requirements that require the contractor to include gas monitoring during project construction and thus address risk factors associated with subsurface gas hazards (**GEO-IAMF#3**). Hazards related to potential migration of hazardous gases caused by the presence of oil fields, gas fields, or other subsurface sources can be reduced or eliminated by following strict federal and state Occupational Safety and Health Administration regulatory requirements for excavations, and by consulting with other agencies as appropriate, such as CalGEM and the California Environmental Protection Agency, Department of Toxic Substances Control, regarding known areas of concern.

Practices would include using safe and explosion-proof equipment during construction, and specified monitoring for gases. Installation of passive or active gas-venting and gas-collection systems, as well as active monitoring of systems and alarms, would be required in underground construction areas and facilities where subsurface gases are present. Installing gas-detection systems enables monitoring the effectiveness of these systems, and adjustments can be made as needed.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to disruption of subsurface oil and gas resources would be similar to those described for Shared Passenger Track Alternative A, because neither LMF is within a methane zone according to the Los Angeles Department of Building and Safety Methane and Methane Buffer Zone Map (2014). The nearest oil field to the 15th Street LMF is the Bandini oil field, about 1 mile southwest. Therefore, the potential for hazardous gases is low. Construction at the LMF site would not provide a route of exposure to subsurface gas hazards that would result in a risk of loss of life or destruction of property in these areas. As with Shared Passenger Track Alternative A, **GEO-IAMF#3** will effectively address risks resulting from encountering potential subsurface gas and subsidence hazards.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives. This area does not directly traverse an oil field and is 0.75 mile south of the Santa Fe Springs oil field. The types of construction activities would be the same as those for the Shared Passenger Track Alternatives. The likelihood of disrupting subsurface oil and gas resources would be low. **GEO-IAMF#3** will effectively address risks resulting from encountering potential subsurface gas and subsidence hazards.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in a larger area than would be modified under the Shared Passenger Track Alternatives. This area would, however, be similar to the area modified under the Shared Passenger Track Alternatives, in that it does not directly traverse an oil field and would be within a similar distance of the nearest oil field (approximately 1.3 miles south of the Coyote East oil field). The types of construction activities would be the same as those for the Shared Passenger Track Alternatives. There is a low potential for hazardous subsurface gases beneath the station site. **GEO-IAMF#3** will effectively address risks resulting from encountering potential subsurface gas and subsidence hazards.

CEQA Conclusion

The potential for disruption of subsurface oil and gas resources during project construction relates to the requirement for foundation piles for the elevated structures within the Bandini and Santa Fe Springs oil fields. Construction may provide a route of exposure to subsurface gas hazards that would result in a risk of loss of life or destruction of property in these areas. However, **GEO-IAMF#3**, which is part of project design, will effectively address risks such that project construction would not exacerbate the potential for injury, loss of life, or damage to property resulting from encountering subsurface gas hazards. Therefore, the impact related to substantial risk caused by disruption of subsurface oil and gas resources during construction would be less than significant and CEQA does not require mitigation.

Impact GSSPR-11: Geologic Units Sensitive for Paleontological Resources Disturbed During Construction

Shared Passenger Track Alternative A

Construction of Shared Passenger Track Alternative A, including the HSR station at ARTIC, relocation of the Commerce and Buena Park Metrolink stations, the 26th Street LMF, and grade separations, would involve clearing, grading, excavation, utility relocation, and other earthmoving actions for the project and in associated staging areas and access routes. Levels of disturbance would vary depending on the construction activity. Along the length of the project section, the majority of track work built at grade would involve excavation with typical construction equipment to a depth of approximately 5 feet below the current grade. The depth of existing utilities would dictate the depth of excavation for their replacement, which may extend up to 30 feet below grade for activities such as sewer relocations. Deep excavations would take place for below-grade sections, such as the trench section at Fullerton Municipal Airport or at underpass grade separations for roadways. Elevated structures and bridgework over the Rio Hondo, San Gabriel River, and other locations would require placement of deep pile foundations.

As discussed in Section 3.9.5.2, Paleontological Resources, the project elements, station sites, and maintenance facility are underlain by geologic units that are sensitive for paleontological resources. Geologic units that have a high sensitivity for paleontological resources include:

- **Younger alluvium at depths greater than 6 feet:** Younger alluvium, at depths greater than 6 feet, has yielded vertebrate specimens and freshwater species of invertebrates. Remains of land plants have also been recovered from this unit.
- **Older alluvium:** The older alluvium has yielded vertebrate fossils of Rancholabrean fauna, including sabretooth cats and Pleistocene megafauna such as mammoth and mastodon.
- **Fernando Formation, Repetto Member:** The Repetto Member of the Fernando Formation has yielded extensive fossil remains of Pliocene marine invertebrates and vertebrates including sharks, fish, porpoises, and whales. In addition, this formation has yielded specimens of birds and land plants.
- **Unnamed marine shale:** Fossils recovered from the unnamed marine shale include Early Pliocene deep sea fish, invertebrates, and remains of land plants.

Therefore, if earth moving, such as grading, excavation, or utility relocation, would occur in areas where sensitive units are exposed at the surface or extend to depths greater than 6 feet, there is the potential to destroy, disturb, or damage unique paleontological resources permanently. Earthwork required for track work, station development, and maintenance facility and electric power utility improvements, such as grading, excavation, utility relocation, or track re-alignment at each station, could affect geologic units with a high sensitivity for unique paleontological resources.

Where geologic units with high paleontological sensitivity are present, construction-related ground disturbance has the potential to result in the loss of other unique (scientifically important but nonunique) paleontological resources. Effects are possible in two situations:

- Where strata with high paleontological sensitivity are exposed at the ground surface in areas subject to ground-disturbing activities
- Where highly sensitive units are not surface exposed, but ground disturbance would extend deep enough to involve underlying highly sensitive materials

The potential for effects would increase with the extent of disturbance, but even limited activity would have the potential to result in the loss of scientifically important resources. However, design characteristics of the project include provisions for avoiding loss of scientifically important fossil resources in areas of high paleontological sensitivity. To prevent the loss of scientifically important resources, the contractor will designate a PRS who will be responsible for determining where and when paleontological resources monitoring should be conducted prior to ground-disturbing activities (**GEO-IAMF#11**). Paleontological resource monitors will be selected by the PRS based on their qualifications; they must meet or exceed the qualifications for a Principal Paleontologist as defined in Caltrans' current Standard Environmental Reference, Volume 1, Chapter 8 (Caltrans 2025). The PRS will be responsible for reviewing the final design and developing a detailed PRMMP. The PRS will be responsible for implementing the PRMMP, including delivery of WEAP training, and evaluation and treatment of finds, if any. The PRMMP will be submitted to the Authority for review and approval (**GEO-IAMF#11**). Prior to groundbreaking, the contractor will provide paleontological resources WEAP training, which management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to attend before beginning work on the project (**GEO-IAMF#14**).

During review of the final design, the PRS will identify the portions of the project section that involve work in paleontologically sensitive geologic units (either on the surface or in the subsurface) (**GEO-IAMF#12**).

This review and evaluation will consider the location, areal extent, anticipated depth of disturbance, construction techniques that are planned or proposed, and geology of the project section and vicinity. Following this review and evaluation, specific language detailing the paleontological monitoring and other requirements will then be incorporated in full detail into the PRMMP (**GEO-IAMF#12**).

During construction, paleontological monitoring and mitigation measures will only apply to those construction-related activities that result in the disturbance of paleontologically sensitive sediments (**GEO-IAMF#13**). The PRMMP will include a description of when and where construction monitoring will be required; emergency discovery procedures; sampling and data-recovery procedures; procedures for preparation, identification, analysis, and curation of fossil specimens and data recovered; and procedures for reporting the results of the monitoring and mitigation program. The PRMMP will be consistent with the SVP guidelines (SVP 2010) or their successors for mitigating construction effects on paleontological resources. The PRMMP will also be consistent with the SVP conditions for receivership of paleontological collections (SVP 1996) and specific requirements of the designated repository for fossils collected (**GEO-IAMF#13**).

If fossils or fossil-bearing deposits are discovered during construction, regardless of the individual making a paleontological discovery, construction activity in the immediate vicinity of the discovery will cease, in order to address the potential for resource effects (**GEO-IAMF#15**). This requirement will be spelled out in both the PRMMP and the WEAP training. Construction activity may continue elsewhere, provided that it continues to be monitored as appropriate. If the discovery is made by someone other than a paleontological resources monitor or the PRS, a paleontological resources monitor or the PRS will immediately be notified. The paleontological resources monitor will prepare and submit monthly reports to the Authority documenting PRMMP execution for compliance monitoring (**GEO-IAMF#13**).

Construction would involve ground disturbance in geologic units identified as having high paleontological sensitivity. However, effects would occur on a limited basis because the above-mentioned IAMFs include effective measures to engage a PRS for direct monitoring during construction, execution of a PRMMP, and provisions to halt construction if paleontological resources are found. These measures will avoid or minimize the destruction of unique paleontological resources in a manner consistent with current accepted standards for such resources.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to potential disturbance of geological units sensitive to paleontological resources during construction would be similar to those described for Shared Passenger Track Alternative A. The 15th Street LMF site is underlain by the same geologic units, with the same paleontological sensitivity, as the 26th Street LMF site. Work 6 feet or more below the ground surface involving these units has the potential to destroy unique, scientifically important paleontological resources. Relative to the 26th Street LMF, ground-disturbing work at the 15th Street LMF could result in greater impacts on paleontological resources because the depth of ground disturbance would be greater at this location than at the 26th Street LMF location. As described in Section 2.10.5, Major Construction Activities, of Chapter 2, the 15th Street LMF yard lead tracks would need to cross under the Olympic Boulevard roadway overcrossing in three shallow trenches. Excavation would be required to a depth of approximately 15 feet to account for soil improvements and construction of formwork for the cast-in-place structures. To establish the connection between the below-grade lead tracks and the yard tracks, the northern portion of the LMF site (approximately 25 acres) would need to be excavated up to a depth of 5 feet and regraded to match the grade of the lead tracks. As depicted on Figure 2-78 in Chapter 2, each track would be within a separate trench to pass through the piers, at a depth of 7 feet. As stated above, incorporation of IAMFs (**GEO-IAMF#11**, **GEO-IAMF#12**, **GEO-IAMF#13**, **GEO-IAMF#14**, and **GEO-IAMF#15**) will avoid or minimize the destruction of unique paleontological resources in a manner consistent with current accepted standards for such resources.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in the same area that would be modified under the Shared Passenger Track Alternatives, which is on soils with highly sensitive older alluvial deposits. The types of construction activities would be the same as those for the Shared Passenger Track Alternatives. Incorporation of IAMFs **(GEO-IAMF#11, GEO-IAMF#12, GEO-IAMF#13, GEO-IAMF#14**, and **GEO-IAMF#15**) will avoid or minimize the destruction of paleontological resources in a manner consistent with current accepted standards for such resources.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Construction of the HSR station platform, facilities, and parking would occur in larger area than would be modified under the Shared Passenger Track Alternatives but would be on the same soils with low-sensitivity younger alluvial deposits. The types of construction activities would be the same as those for the Shared Passenger Track Alternatives. Incorporation of IAMFs (**GEO-IAMF#11**, **GEO-IAMF#12**, **GEO-IAMF#13**, **GEO-IAMF#14**, and **GEO-IAMF#15**) will avoid or minimize the destruction of paleontological resources in a manner consistent with current accepted standards for such resources.

CEQA Conclusion

The impact under CEQA related to potential destruction of a unique paleontological resource or site during project construction would be less than significant. Construction would involve ground disturbance in geologic units identified as having high paleontological sensitivity. However, **GEO-IAMF#11**, **GEO-IAMF#12**, **GEO-IAMF#13**, **GEO-IAMF#14**, and **GEO-IAMF#15**, which are part of the project design, include effective measures to engage a PRS for direct monitoring during construction, implement a PRMMP, and incorporate provisions to halt construction if paleontological resources are found. These measures will avoid destruction of unique paleontological resources and impacts would be less than significant under CEQA. Therefore, CEQA does not require mitigation.

Operational Impacts

Impact GSSPR-12: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Operation

Shared Passenger Track Alternative A

Shared Passenger Track Alternative A would not intersect mapped faults exhibiting offset of Holocene-age deposits.[8] Furthermore, Shared Passenger Track Alternative A would not include operational or maintenance activities that would increase stresses in the Earth's crust and therefore would not accelerate the potential for surface fault rupture or ground shaking (Authority 2025a). Therefore, Shared Passenger Track Alternative A would not increase exposure of people or structures to potential loss of life, injuries, or destruction from surface fault rupture or ground shaking during operation caused by the exacerbation of existing geologic hazards.

Shared Passenger Track Alternative B

Impacts would be the same as those described for Shared Passenger Track Alternative A. The 15th Street LMF is not within an Alquist-Priolo Earthquake Fault Zone. No known active faults project toward the 15th Street LMF site. The nearest mapped active faults to the site with displacement of Holocene-age deposits are the Hollywood fault and Newport-Inglewood fault approximately 7 miles north and 7.5 miles west, respectively, from this LMF site. Therefore, operation of the 15th Street LMF would not directly or indirectly cause fault rupture or seismically induced ground shaking that would increase exposure of people or structures to the potential loss of life, injuries, or destruction from surface fault rupture or seismically induced ground shaking.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Operation of the HSR station option would occur in a larger area than would be required under the Shared Passenger Track Alternatives, but the site is not within an Alquist-Priolo Earthquake Fault Zone, and no known active faults project toward the station site. Therefore, the Norwalk/Santa Fe Springs HSR Station Option would not directly or indirectly cause fault rupture or seismically induced ground shaking that would increase exposure of people or structures to the potential loss of life, injuries, or destruction from surface fault rupture or seismically induced ground shaking during operation.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those of the Shared Passenger Track Alternatives in the station area. Operation of the HSR station option would occur in a larger area than would be required under the Shared Passenger Track Alternatives, but the site is not within an Alquist-Priolo Earthquake Fault Zone, and no known active faults project toward the station site. Therefore, the Fullerton HSR Station Option would not directly or indirectly cause fault rupture or seismically induced ground shaking that would increase the exposure of people or structures to the potential loss of life, injuries, or destruction from surface fault rupture or seismically induced ground shaking during operation.

[8] As discussed in Table 3.9-7, the PHT fault underlies the project footprint, terminating approximately 2 miles below ground surface. However, blind thrust faults, while capable of causing ground shaking, do not pose a potential surface fault rupture hazard.

CEQA Conclusion

Operation of the Shared Passenger Track Alternatives would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction above current conditions. The impact would therefore be less than significant, and CEQA does not require mitigation.

Impact GSSPR-13: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction and Other Types of Seismically Induced Ground Failure During Operation

Shared Passenger Track Alternative A

Secondary seismic hazards include liquefaction and seismically induced ground failures. **GEO-IAMF#1** requires the contractor to address geological constraints prior to and during construction. Therefore, the design of the project will account for the effects of seismically induced ground failure during operation.

The project alignment crosses several liquefaction zones (CDMG 1998a–f, 1999a–d). Project design will require the Authority to document how the most recently updated Caltrans seismic design criteria (Caltrans 2019) were used in the design of HSR structures supported in or on the ground (**GEO-IAMF#7**) as well as the HSR design criteria manual to address the risk from secondary seismic hazards. Specifications include that site-specific geotechnical investigations will be carried out as the design work progresses to determine whether the type and density of the soil could result in conditions that would be susceptible to liquefaction and in need of stabilization. Accordingly, site-specific evaluation will be required along portions of the alignment that are within liquefaction zones, including the Buena Park Metrolink Station relocation site. Detailed slope stability evaluations will also be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes will be carried out, as appropriate, to reduce the potential for seismically induced slope failures; localized instabilities that may occur will be handled as a maintenance issue. Under **GEO-IAMF#2**, during operation, slope monitoring will be performed at sites identified in the CMP where a potential for long-term ground instability exists from gravity or seismic loading. These measures incorporate professional standards using site-specific geotechnical data to reduce the risk of ground movement at project structures as a result of seismic activity. Additionally, the contractor will conform to guidelines specified by relevant transportation and building agencies and codes (**GEO-IAMF#10**), requiring the Authority to account for geotechnical properties during project design and construction and thus address risk factors associated with seismically induced ground shaking.

In the event of an earthquake, HSR operational procedures will address potential hazards from ground failure. To protect personal safety, property, and HSR integrity in case of an earthquake during HSR operations, the contractor will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (**GEO-IAMF#8**). A network of instruments will be installed to provide ground-motion data, which will be used in conjunction with the HSR instrumentation and controls system. Train operation will cease in the event of dam inundation that would endanger train safety through the project site. Shutting down operations temporarily during or after a potentially damaging earthquake will address the risk of personal injury or property damage from liquefaction and ground failure.

Seismically induced ground shaking and secondary seismic hazards could occur in the seismicity RSA. However, the above-mentioned IAMFs address potential effects on HSR operations from seismically induced ground shaking and secondary seismic hazards, including shear forces, displacements, and liquefaction; therefore, project operation will not exacerbate risks from these hazards. The above-mentioned IAMFs include effective practices to implement current Caltrans seismic design criteria in the design of HSR structures supported in or on the ground and install a network of instruments to monitor ground motion and shut down HSR operations in case of earthquake. Therefore, project operation would avoid a permanent increase in risks associated with liquefaction and ground failure.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to secondary seismic hazards during operation would be similar to those described for Shared Passenger Track Alternative A. A portion of the

15th Street LMF site is within a CGS-delineated liquefaction zone. A site-specific study would be needed to determine the extent of liquefiable soils. Detailed slope stability evaluations will also be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes will be carried out, as appropriate, to reduce the potential for seismically induced slope failures; localized instabilities that may occur will be handled as a maintenance issue.

The same IAMFs as for Shared Passenger Track Alternative A (**GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#7**, **GEO-IAMF#8**, and **GEO-IAMF#10**) address potential effects on HSR operations from seismically induced ground shaking and secondary seismic hazards, including shear forces, displacements, and liquefaction; therefore, project operation will not exacerbate risks from these hazards.

GEO-IAMF#1 includes employing various methods to mitigate for the risk of ground failure from unstable soils. Under **GEO-IAMF#2**, during operation, slope monitoring will be performed at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading. Structures will be designed consistent with Caltrans seismic design criteria (Caltrans 2019) or equivalent standards; therefore, there is a low potential for liquefaction-induced risks to affect structures within the project footprint (**GEO-IAMF#7**). These measures incorporate professional standards using site-specific geotechnical data to reduce risk of ground movement at project structures as a result of seismic activity. **GEO-IAMF#8** requires that the contractor install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks. Furthermore, the Authority will conform to guidelines specified by relevant transportation and building agencies and codes (**GEO-IAMF#10**), requiring the Authority to account for geotechnical properties during project design and construction.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for Shared Passenger Track Alternative A. Operation of the HSR station option would occur in a larger area than what would be modified under Shared Passenger Track Alternative A, but the HSR station option site is not within a mapped liquefaction zone. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. **GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#7**, **GEO-IAMF#8**, and **GEO-IAMF#10** address potential effects on HSR operations from seismically induced ground shaking and secondary seismic hazards, including shear forces, displacements, and liquefaction; therefore, project operation will not exacerbate risks from these hazards.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for Shared Passenger Track Alternative A. Operation of the HSR station option would occur in a larger area than what would be modified under Shared Passenger Track Alternative A, but the site is within the same CGS-delineated liquefaction zone and has the same potential effects from liquefaction. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. **GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#7**, **GEO-IAMF#8**, and **GEO-IAMF#10** address potential effects on HSR operations from seismically induced ground shaking and secondary seismic hazards, including shear forces, displacements, and liquefaction; therefore, project operation will not exacerbate risks from these hazards.

CEQA Conclusion

The impact under CEQA related to liquefaction and seismically induced ground failure during project operation would be less than significant. **GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#7**, **GEO-IAMF#8**, and **GEO-IAMF#10** will effectively address risks associated with these secondary seismic hazards. Furthermore, project operation would not cause the risk of loss, injury, or death beyond what people are currently exposed to in the RSA from secondary seismic hazards. Therefore, CEQA does not require mitigation.

Impact GSSPR-14: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Operation

Shared Passenger Track Alternative A

Portions of the project footprint are within the flood inundation zones of Hansen Dam, Garvey Reservoir, Whittier Narrows Dam, Brea Dam, Fullerton Dam, Carbon Canyon Dam, and Prado Dam (refer to Figure 3.9-6). It should be noted that most areas within these inundation zones are urbanized. The risk of exposure to flooding from dam failure during project operations is no greater than under existing conditions. It would not increase the exposure of people or structures to potential loss of life, injury, or destruction beyond what they are currently exposed to in the resource hazards RSA. However, in the event of seismically induced flooding, compliance with the applicable transportation and building codes in **GEO-IAMF#10** will minimize risks to people and structures during operation. Nonetheless, in the event of an earthquake, HSR operational procedures will address potential hazards from dam failure. In order to protect personal safety, property, and HSR integrity in case of an earthquake during HSR operations, the contractor will install a control system to temporarily shut down HSR operations during or after a potentially damaging earthquake to reduce risks (**GEO-IAMF#8**). A network of instruments will be installed to provide ground-motion data, which will be used in conjunction with the HSR instrumentation and controls system. Train operation will cease in the event of dam inundation that would endanger train safety. Shutting down operations temporarily during or after a potentially damaging earthquake will address the risk of personal injury or property damage from inundation in the unlikely event of a seismically induced dam failure. Procedures will be in place to identify possible water routes from a dam breach and move trains that are in operation out of the anticipated water route.

Furthermore, as noted above, the project would not exacerbate seismic conditions. Therefore, project operation would avoid a permanent increase in risks associated with seismic-related dam failure or seiche.

Shared Passenger Track Alternative B

The proposed LMF at 15th Street would not increase deep stresses in the Earth’s crust. The LMF would not directly or indirectly cause a seismically induced seiche during operation. However, in the event of seismically induced flooding, implementation of the relevant transportation and building codes in **GEO-IAMF#10** will minimize risks to people and structures during operation. In addition, to protect personal safety, property, and HSR integrity in case of earthquake during HSR operations, the contractor will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (**GEO-IAMF#8**).

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Operation of the HSR station option would occur in a larger area than what would be required under the Shared Passenger Track Alternatives but it is within the same dam inundation area as depicted on Figure 3.9-6. In the event of seismically induced flooding, implementation of the relevant transportation and building codes in **GEO-IAMF#10** will minimize risks to people and structures during operation. In addition, to protect personal safety, property, and HSR integrity in case of an earthquake during HSR operations, the contractor will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (**GEO-IAMF#8**).

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Operation of the HSR station option would occur in a larger area than what would be required under the Shared Passenger Track Alternatives but it is within the same dam inundation area as depicted on Figure 3.9-6. In the event of seismically induced flooding, implementation of the relevant transportation and building codes in **GEO-IAMF#10** will minimize risks to people and structures during operation. In addition, to protect personal safety, property, and HSR integrity in case of an earthquake during HSR operations, the contractor will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks (**GEO-IAMF#8**).

CEQA Conclusion

The impact under CEQA related to seismically induced flooding during project operation would be less than significant. Because the risk of dam failure is low for the project and because the project would not exacerbate seismic conditions, it would not cause the risk of loss, injury, or death beyond what people are currently exposed to in the RSA from the potential for seismically induced dam failure with resulting risk of inundation or seiche. Therefore, CEQA does not require mitigation.

Impact GSSPR-15: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Associated with Cut-and-Fill Slopes, or Landslides, Including Seismically Induced Landslides

Shared Passenger Track Alternative A

There are no mapped landslides along the project footprint, and the topography is generally sloping less than a few degrees. Shared Passenger Track Alternative A would not directly or indirectly cause or accelerate the potential for slope failure hazards associated with pre-existing landslides during operation. Therefore, the project would not permanently increase potential for slope failure hazards associated with pre-existing landslides during operation.

Where a potential for long-term instability exists from gravity or seismic loading along cut-and-fill slopes, the Authority will incorporate slope monitoring by a registered engineering geologist into the operations and maintenance procedures at sites identified in the CMP (**GEO-IAMF#2**). Monitoring will provide information to identify and repair ground movement before it can damage track integrity (**GEO-IAMF#8**). In addition, **GEO-IAMF#1** requires the contractor to address geological constraints prior to and during construction. Project design will require HSR trains to be equipped with autonomous equipment for daily track surveys, once tracks are operational, as part of a stringent track-monitoring program (**GEO-IAMF#9**). The track-monitoring program will provide early warning of reduced track integrity in case of ground settlement. Therefore, the project would not permanently increase the potential for slope failure hazards associated with cut-and-fill slopes during operation.

Shared Passenger Track Alternative B

With the LMF at 15th Street, impacts related to slope failure hazards during operation would be similar to those described for Shared Passenger Track Alternative A. Landslide potential is considered negligible for the reasons stated above and potential effects from slope failure hazards associated with cut-and-fill slopes during operations are considered negligible after necessary IAMFs (**GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#8**, and **GEO-IAMF#9**) and protection systems are incorporated during design and construction. Therefore, with incorporation of IAMFs, the LMF components will not increase the potential for slope failure hazards.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because there are no additional cut-and-fill slopes associated with the HSR station elements. Landslide potential is considered negligible, and potential effects from slope failure hazards during operations are also considered negligible after incorporation of IAMFs (**GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#8**, and **GEO-IAMF#9**).

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because there are no additional cut-and-fill slopes associated with the HSR station elements. Landslide potential is considered negligible, and potential effects from slope failure hazards during operations are also considered negligible after incorporation of IAMFs (**GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#8**, and **GEO-IAMF#9**).

CEQA Conclusion

The impact under CEQA related to slope failure hazards during project operation would be less than significant. Project features (**GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#8**, and **GEO-IAMF#9**) will ensure that operation of the project will not increase risks from slope failure hazards, including pre-existing landslide and cut-and-fill slopes, beyond levels of exposure that currently exist. Therefore, CEQA does not require mitigation.

3.9.7 Mitigation Measures

Construction and operational impacts under the alternatives related to GSSPR would not result in significant adverse effects. Therefore, no mitigation measures would be required.

3.9.7.1 Early Action Projects

None of the early action projects that are evaluated as part of the project would result in significant impacts related to GSSPR under CEQA or an impact under NEPA. Therefore, no mitigation measures specific to early action projects are required.

3.9.8 NEPA Impacts Summary

This section summarizes the impacts of the Shared Passenger Track Alternatives and compares them to the anticipated impacts of the No Project Alternative.

3.9.8.1 No Project Alternative

The No Project Alternative represents the planned transportation system and major planned land use changes anticipated by 2040 without the project. Under the No Project Alternative, recent development trends are anticipated to continue, leading to impacts on GSSPR. These include localized deposits of soil with low bearing capacity, hazards from steep slopes near streams and rivers, loss of topsoil, constraints on the potential for oil and gas resource development, and loss of paleontological resources. Future development could also result in development in less suitable areas, where the risk of geologic and seismic hazards is higher than in existing developed areas. Ultimately, this would result in more risk to the public and a greater chance of property damage. Future developments planned under the No Project Alternative would require individual environmental review, such as permits, regulatory requirements, and design standards. Future projects would need to comply with Title 24 California Building Standards Code requirements with adherence to geotechnical and stability regulations and would be designed to avoid or minimize effects.

3.9.8.2 Shared Passenger Track Alternatives

Construction of the Shared Passenger Track Alternatives is not expected to result in adverse effects as further described below.

- **Impact GSSPR-1:** The project section does not traverse active faults with documented Holocene-age fault rupture or include construction activities that would induce fault rupture, seismic hazards, or ground shaking.
- **Impact GSSPR-2:** Temporary structures, such as shoring and scaffoldings, may be subject to moderate to strong ground shaking during construction, and thereby potential liquefaction hazards and subsequent settlement. **GEO-IAMF#7** and **GEO-IAMF#10** will reduce the effect from seismically induced ground shaking and secondary seismic hazards.
- **Impact GSSPR-3:** Construction would not aggravate the risk of exposing people or structures to potential effects because of dam failure, liquefaction, and other secondary seismic activities or seismic-related ground failure beyond the existing level already present.

- **Impact GSSPR-4:** Construction would involve cut-and-fill slopes. Any cut-and-fill slopes that may be planned are anticipated to be less than 20 feet in height. Temporary cut slopes made during construction excavation would be sloped at appropriate angles based on the shear strength parameters of the earth materials at the locations of planned excavations. Potentially collapsible soils may be present at localized areas along the project section; the potential for these to occur is low to moderate in each city along the project section. The effect of collapsible soils could potentially endanger temporary construction structures, equipment, and employees throughout project construction. **GEO-IAMF#10** will reduce the effect from cut-and-fill slopes and collapsible soils.
- **Impact GSSPR-5:** During project construction, changes to vegetation coverage from project removal could expose unprotected soils to erosive forces of wind and water. **GEO-IAMF#1**, **GEO-IAMF#10**, and **HYD-IAMF#3** will be effective in avoiding substantial soil erosion or loss of topsoil.
- **Impact GSSPR-6:** Construction would not exacerbate hazards involving unstable soils and locally shallow groundwater, resulting in injury to people or damage to property. **GEO-IAMF#1**, **GEO-IAMF#7**, and **GEO-IAMF#10** include effective practices to address unstable soils, settlement caused by groundwater withdrawal, and slope failure caused by seismic activity, thereby minimizing effects through slope monitoring and subsidence monitoring so that ground movement can be addressed before it can damage track integrity.
- **Impact GSSPR-7:** The project may experience risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater. **GEO-IAMF#10** requires the contractor to account for geotechnical properties during the construction phases of the project and therefore address risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater.
- **Impact GSSPR-8:** Construction would not aggravate hazards involving corrosive soils, resulting in injury to people or damage to property. **GEO-IAMF#10** will avoid the potential effects on personal safety of passengers and HSR infrastructure from the effects presented by corrosive soils. Construction also would not exacerbate hazards involving expansive soils, resulting in injury to people or damage to property. **GEO-IAMF#10** will avoid the potential effects on personal safety and infrastructure during construction from the effects presented by expansive soils.
- **Impact GSSPR-9:** Construction of the project would involve rerouting access to multiple oil and gas wells, potentially changing their productivity. **SS-IAMF#4** compensates owners for losses associated with changes in productivity.
- **Impact GSSPR-10:** Construction would involve drilling of foundation piles, possibly exposing subsurface gas hazards. This would potentially pose a safety risk to workers and others in the vicinity. **GEO-IAMF#3** will avoid an increase in the effects related to potential increases in safety risk from construction near active oil and gas wells).
- **Impact GSSPR-11:** Construction would involve earthwork that could affect geologic units with a high sensitivity for paleontological resource. **GEO-IAMF#11**, **GEO-IAMF#12**, **GEO-IAMF#13**, **GEO-IAMF#14**, and **GEO-IAMF#15** include provisions for avoiding the loss of scientifically important fossil resources in areas of high paleontological sensitivity.

Operation of the Shared Passenger Track Alternatives is not expected to result in adverse effects as further described below.

- **Impact GSSPR-12:** Although operation of the project would not cause or accelerate the potential for surface fault rupture or ground shaking, the project section is in an area that exposes people and structures to seismic hazards. The Shared Passenger Track Alternatives would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction above current conditions.

- **Impact GSSPR-13:** During operation, secondary seismic hazards include liquefaction, seismically induced slope failures, and seismically induced ground failure. **GEO-IAMF#1**, **GEO-IAMF-2**, **GEO-IAMF#7**, **GEO-IAMF-8**, and **GEO-IAMF#10** will reduce the effect from secondary hazards such as liquefaction and slope failure.
- **Impact GSSPR-14:** The risk of dam failure during operation is believed to be low for the project, including facilities such as stations (both proposed and existing station modifications), the LMF, and grade separations. This low risk suggests that the risk of inundation from dam failure is also considered low along the project section. **GEO-IAMF#10** will minimize risks to people and structures during operation, and in accordance with **GEO-IAMF#8** the contractor will install a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake to reduce risks.
- **Impact GSSPR-15:** There are no mapped landslides along the project footprint, and the topography is generally sloping less than a few degrees. The project would not directly or indirectly cause or accelerate the potential for slope failure hazards associated with pre-existing landslides during operation. Therefore, the project would not permanently increase potential for slope failure hazards associated with pre-existing landslides during operation. **GEO-IAMF#1**, **GEO-IAMF#2**, **GEO-IAMF#8**, and **GEO-IAMF#9** would provide further protection during operation.

Table 3.9-11 provides a comparison of the potential impacts of the project alternatives followed by a summary of the impacts.

Table 3.9-11 Comparison of Project Alternative Impacts on Geology, Soils, and Seismicity, and Paleontological Resources

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton	NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative A	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative B	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Fullerton
Impact GSSPR-1: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Construction	The types of construction that could potentially result in induced seismic faulting or seismically induced ground shaking are not required for the project. There are no known active faults with documented Holocene-age fault rupture that traverse the project footprint and alignment. The up-dip termination of the PHT fault is approximately 1.5 miles beneath the alignment and, therefore, is not a ground rupture hazard from faulting. Active folding in Holocene-age alluvium has been reported near the PHT fault's Santa Fe Segment. Therefore, there is a potential hazard related to tectonic uplift and tilting during a potential future large-magnitude earthquake on the PHT fault.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-2: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction During Construction	Temporary structures associated with the construction of Shared Passenger Track Alternative A may be exposed to liquefaction hazards and subsequent settlement as a result of strong ground shaking. Project features will minimize direct and indirect risks to life and property resulting from liquefaction and ground failure during construction. These project features include conforming to guidelines specified by relevant transportation and building agencies including designing temporary construction structures in accordance with Caltrans seismic design criteria and applying construction safety measures like evacuation plans. Furthermore, construction activities would not cause a regional increase in groundwater elevations or involve the types of activities that would directly or indirectly cause or accelerate the potential for seismic settlement.	Similar to Shared Passenger Track Alternative A. A portion of the 15th Street LMF is within a CGS-delineated liquefaction zone. However, construction activities would not cause a regional increase in groundwater elevations or other geologic conditions that would cause or accelerate the potential for liquefaction during construction. Furthermore, any temporary local fluctuations that may occur in relation to trenching or other construction activities would adhere to relevant transportation and building agencies and codes.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option		NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation			
							Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option	
			Norwalk/Santa Fe Springs	Fullerton					Norwalk/Santa Fe Springs	Fullerton
Impact GSSPR-3: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Construction	Portions of the Shared Passenger Track Alternative A footprint are within flood inundation zones. However, because of regulatory oversight and the comparatively shorter duration of construction (as opposed to operation), the potential for seiche or dam failure from seismically induced flooding hazard is unlikely during construction. Moreover, the risk of exposure to flooding during construction is not greater than under existing conditions. The project would not involve activities that would trigger a seismic event.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-4: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Hazards Associated with Unstable Soils, Cut-and-Fill Slopes, or Collapsible Soils, Including Seismically Induced Landslides During Construction	No substantial cut-and-fill slopes are planned along the project section for Shared Passenger Track Alternative A. Temporary cut slopes made during construction excavation will be at appropriate inclinations based on the shear strength parameters of the earth materials at the locations of planned excavations. Potentially collapsible soils may be present along the Shared Passenger Track Alternative A footprint. Project features will minimize direct and indirect risks to life and property resulting from liquefaction and ground failure during construction. These project features include conforming to guidelines specified by relevant transportation and building agencies. Construction of the project would not temporarily increase the risk of exposing people or structures to potential effects because of slope failure hazards associated with unstable soils, cut-and-fill slopes, or landslides beyond what currently exists in the RSA.	Similar to Shared Passenger Track Alternative A. Although the effects of soil failure would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of these temporary activities relative to the infrequency of large earthquakes. In addition, temporary slopes would be built with an adequate factor of safety to avoid slope failures, and would be sloped at appropriate angles based on the shear strength parameters of the earth materials at the locations of planned excavations as required by the applicable codes and regulations. The project section would not cross mapped landslide boundaries based on published geologic maps.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton	NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative A	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative B	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Fullerton
Impact GSSPR-5: Soil Erosion as a Result of Construction	Project features for construction of Shared Passenger Track Alternative A will minimize substantial soil erosion or the loss of topsoil that would adversely affect the viability of the ecosystem or productivity through the adoption of BMPs that protect exposed soil, include soil stabilization through the use of stabilizers, mulches, revegetation, and covering of exposed work areas with biodegradable geotextiles.	Similar to Shared Passenger Track Alternative A. Shared Passenger Track Alternative B would implement BMPs that protect exposed soil and include soil stabilization measures, which would minimize substantial soil erosion and the loss of topsoil.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Similar to Shared Passenger Track Alternative A. The Fullerton HSR Station Option would require greater disturbance of land during construction, but through BMPs and inclusion of soil stabilization measures, effects related to substantial soil erosion and loss of topsoil would be minimized.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-6: Be Located on 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 During Construction	Ground subsidence is a time-dependent process, and the likelihood of ground subsidence during construction is considered low because of the comparatively short duration of construction. Construction or modification of bridges, culverts, grade separations, open trench sections, and near surface water features (where groundwater levels may be locally higher) could require dewatering during construction. The amount of dewatering is likely to be relatively small and done in widely spaced locations. Effects from groundwater dewatering would be temporary, because dewatering would cease once construction has been completed. Controlling the amount of groundwater withdrawal would counteract the potential for subsidence to occur. The project alignment is relatively flat; therefore, the probability for lateral spreading in response to the liquefaction of subsurface soil is low. However, there is a possibility that localized lateral spreading may occur in areas where the project alignment crosses over creeks and river channels. The project will incorporate features that reduce the effects of dewatering by controlling and minimizing groundwater withdrawal and requiring treatment before discharge. Therefore, the project would not increase the potential for subsidence.	Similar to Shared Passenger Track Alternative A. The effect of subsidence and lateral spreading during construction of the 15th Street LMF, would be similar to the effect described for Shared Passenger Track Alternative A. Shared Passenger Track Alternative B would implement the same project features to reduce the effects of dewatering by controlling and minimizing groundwater withdrawal and requiring treatment before discharge.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option		NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation			
							Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option	
			Norwalk/Santa Fe Springs	Fullerton					Norwalk/Santa Fe Springs	Fullerton
Impact GSSPR-7: Difficult Excavation Encountered During Construction	Impacts from difficult excavation encountered for Shared Passenger Track Alternative A during construction will be minimized by project features that require the contractor to account for geotechnical properties during the construction phases of the project and, thus, address risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater.	Similar to Shared Passenger Track Alternative A. With the LMF at 15th Street, difficult excavation encountered during construction would be similar to that described for Shared Passenger Track Alternative A, with an additional area of construction that has the potential to encounter boulder zones. The 15th Street LMF is adjacent to the Los Angeles River, and the presence of cobbles and boulders should be anticipated and construction may require specialized drilling equipment. However, Shared Passenger Track Alternative B would include the same project features to minimize impacts from difficult excavation encountered during construction.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-8: Soil Corrosion and Expansion Hazards as a Result of Construction	There are soils that exhibit expansive or corrosive characteristics within the Shared Passenger Track Alternative A footprint. Project features will minimize direct and indirect risks to life and property from corrosive and expansive soils conforming to guidelines specified by relevant transportation and building codes. Additionally, if it is anticipated that temporary construction structures would be in place long enough, then the governing codes may consider these structures to be permanent and they would be designed accordingly. These codes would provide for construction of permanent structures to withstand geologic constraints.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton	NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative A	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative B	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Fullerton
Impact GSSPR-9: Availability of Mineral or Energy Resources as a Result of Construction	The project would not cross areas of known geothermal resources and there is no mining of mineral resources in the RSA. Therefore, project construction would not permanently affect the availability of geothermal or mineral resources. There are oil wells within 200 feet of the HSR track centerline. The contractor will inspect wells to assess their status and wells will be dealt with in accordance with CalGEM standards and in coordination with the owner. In the case that relocated wells do not attain the current production rates of the now-abandoned active wells, the Authority will be responsible for compensating the well owner for lost production.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-10: Substantial Risk Caused by Disruption of Subsurface Oil and Gas Resources as a Result of Construction	In the northern and central portions, the RSA traverses three oil fields that have a high probability of containing methane and other subsurface gases. The potential for encountering subsurface gases is considered high where foundation piles would be drilled, including for elevated structures in the oil fields. Project features will minimize direct and indirect risks to life and property from exposure inhalation or explosion of hazardous in-situ gas by conforming with OSHA regulatory requirements for excavations; installing gas monitoring, collecting, and ventilating systems; and using explosion-proof equipment.	Similar to Shared Passenger Track Alternative A. The nearest oil field to the 15th Street LMF is the Bandini oil field, about 1 mile southwest. At this distance, the potential for hazardous gases is low.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-11: Geologic Units Sensitive for Paleontological Resources Disturbed During Construction	Construction of Shared Passenger Track Alternative A would involve ground disturbance in geologic units identified as having high paleontological sensitivity. However, effects would occur on a limited basis because the project includes effective measures to engage a PRS for direct monitoring during construction, execution of a PRMMP, and provisions to halt construction if paleontological resources are found. These measures will avoid or reduce the permanent potential loss of information in a manner consistent with current accepted standards for paleontological resources.	Similar to Shared Passenger Track Alternative A. Relative to the 26th Street LMF, ground-disturbing work at the 15th Street LMF may result in greater impacts on unique paleontological resources because the depth of ground disturbance would be greater at this location than at the 26th Street LMF location.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option		NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation			
			Norwalk/Santa Fe Springs	Fullerton			Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton
Impact GSSPR-12: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Operation	The project does not include operational or maintenance activities that would increase stresses in the Earth's crust and, therefore, would not increase risk of seismic movement. The nearest active fault to the project footprint and alignment with documented Holocene fault rupture is outside of the project footprint and would not result in risk of fault rupture within the project footprint. Therefore, the project would not directly or indirectly cause fault rupture during operation.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-13: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction and Other Types of Seismically Induced Ground Failure During Operation	Shared Passenger Track Alternative A could experience secondary seismic hazards, including liquefaction, seismically induced slope failures, and seismically induced ground failure. Project features will minimize direct and indirect risks to life and property resulting from liquefaction and ground failure during operation, including using seismic design standards in the structural design, using early warning systems that would be triggered by strong ground motion, and shutting down train operations during or after an earthquake.	Similar to Shared Passenger Track Alternative A. A portion of the 15th Street LMF site is within a CGS-delineated liquefaction zone. However, the same project features discussed for Shared Passenger Track Alternative A would minimize direct and indirect risks to life and property resulting from liquefaction and ground failure during operation.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact GSSPR-14: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Operation	The risk of dam failure is believed to be low for the project section. Furthermore, as noted above, the project would not exacerbate seismic conditions. Therefore, project operation would avoid a permanent increase in risks associated with seismic-related dam failure or seiche.	Similar to Shared Passenger Track Alternative A. The LMF site at 15th Street is approximately 220 feet above mean sea level. Although large flood-control reservoirs are upgradient of the proposed LMF site, the risk of damage from seiches is considered low because of the small volume of water present and the distance of the reservoirs to the site (24 miles upstream of the northern end of the project alignment). The LMF site components would not increase deep stresses in the Earth's crust or directly or indirectly cause a seismically induced seiche during operation.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option		NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation			
			Norwalk/Santa Fe Springs	Fullerton			Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton
Impact GSSPR-15: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Associated with Cut-and-Fill Slopes, or Landslides, Including Seismically Induced Landslides	There are no mapped landslides within the footprint of Shared Passenger Tack Alternative A. Precautions taken during construction would also minimize risks prior to operation of the project. Furthermore, project features will minimize direct and indirect risks to life and property resulting from unstable soils, cut-and-fill slopes, and landslides during operation. Features include slope monitoring by a registered engineering geologist and a requirement for HSR trains to be equipped with autonomous equipment for daily track surveys. The track-monitoring program will provide early warning of reduced track integrity in case of ground settlement. Therefore, the project would not permanently increase potential for slope failure hazards associated with cut-and-fill slopes during operation.	Similar to Shared Passenger Track Alternative A. Landslide potential is considered negligible for the same reasons discussed for Shared Passenger Track Alternative A and potential effects from slope failure hazards associated with cut-and-fill slopes during operations are considered negligible through implementation of project features and protection systems during design and construction.	Same impacts as the Shared Passenger Track Alternatives in the station area.	Same impacts as the Shared Passenger Track Alternatives in the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

BMP = best management practice; CalGEM = California Geologic Energy Management Division; Caltrans = California Department of Transportation; CGS = California Geological Survey; CMP = Construction Management Plan; EIR/EIS = environmental impact report/environmental impact statement; HSR = high-speed rail; LMF = light maintenance facility; N/A = not applicable; NEPA = National Environmental Policy Act; OSHA = Occupational Safety and Health Administration; PHT = Puente Hills blind thrust; PRMMP = Paleontological Resources Monitoring and Mitigation Plan; PRS = paleontological resources specialist; RSA = resource study area

3.9.9 CEQA Significance Conclusions

As described in Section 3.9.4.5, Methods for Determining Significance Under CEQA, the impacts of project actions under CEQA are evaluated against thresholds to determine whether a project action would result in no impact, a less-than-significant impact, or a significant impact. Table 3.9-12 provides a summary of the CEQA determination of significance for construction and operational impacts discussed in Section 3.9.6.3, Project Impacts.

Table 3.9-12 CEQA Significance Conclusions for Geology, Soils, Seismicity, and Paleontological Resources

Impact	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Construction				
Impact GSSPR-1: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Seismically Induced Ground Shaking During Construction	Less than significant for both alternatives. The project would not cause or accelerate the potential for surface fault rupture and would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-2: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction During Construction	Less than significant for both alternatives. Project features will avoid directly or indirectly causing substantial adverse effects, including an increase in risk to personal injury, loss of life, or destruction of property, from project construction that are associated with seismically induced ground shaking and secondary seismic hazards.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-3: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Construction	Less than significant for both alternatives. The project would not increase exposure of people or structures to potential loss of life, injuries, or destruction beyond what they are exposed to currently in the RSA from earthquake-induced flooding and seiche.	No mitigation measures are required	Not applicable	All alternatives and options

Impact	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Impact GSSPR-4: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Hazards Associated with Unstable Soils, Cut-and-Fill Slopes, or Collapsible Soils, Including Seismically Induced Landslides During Construction	Less than significant for both alternatives. Project features will avoid the risk of exposing people or structures to potential effects beyond slope failure hazards associated with unstable soils, cut-and-fill slopes, collapsible soils, or landslides that currently exist in the RSA.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-5: Soil Erosion as a Result of Construction	Less than significant for both alternatives. Project features include effective measures to avoid substantial soil erosion or loss of topsoil through incorporation of BMPs that account for soil properties and development of a dewatering plan.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-6: Be Located on 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 During Construction	Less than significant for both alternatives. The Authority will reduce the effects of dewatering by controlling and minimizing groundwater withdrawal and requiring treatment before discharge. The project design requires that structures designated as temporary by Caltrans will be designed consistent with Caltrans seismic design criteria equivalent standards. In addition, a series of state and federal regulations to which adherence is required will be identified.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-7: Difficult Excavation Encountered During Construction	Less than significant for both alternatives. The contractor will account for geotechnical properties during project design and construction. Additionally, design and construction practices will address risk factors associated with difficult excavation conditions such as hardpan and shallow groundwater. Project construction would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavations.	No mitigation measures are required	Not applicable	All alternatives and options

Impact	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Impact GSSPR-8: Soil Corrosion and Expansion Hazards as a Result of Construction	Less than significant for both alternatives. The project design will effectively address hazards such that project construction would not exacerbate the existing corrosive or shrink-swell potential of the soils in the RSA. The project will incorporate requirements to treat or replace corrosive and expansive soils and implement best available practices as specified by relevant transportation and building agencies and codes and document this incorporation.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-9: Availability of Mineral or Energy Resources as a Result of Construction	Less than significant for both alternatives. The project design will effectively address risks such that project construction will not make a known petroleum or natural gas resource of regional or statewide value unavailable to extraction through the physical presence of the project either at the ground surface or subsurface. The Authority would compensate well owners to offset loss of productivity that might result from well relocation.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-10: Substantial Risk Caused by Disruption of Subsurface Oil and Gas Resources as a Result of Construction	Less than significant for both alternatives. The project design will effectively address risks such that project construction would not exacerbate the potential for injury, loss of life, or damage to property resulting from encountering subsurface gas hazards.	No mitigation measures are required	Not applicable	All alternatives
Impact GSSPR-11: Geologic Units Sensitive for Paleontological Resources Disturbed During Construction	Less than significant for both alternatives. The project design includes effective measures to engage a PRS for direct monitoring during construction, implements a PRMMP, and incorporates provisions to halt construction if paleontological resources are found. These measures will avoid or minimize destruction of unique paleontological resources.	No mitigation measures are required	Not applicable	All alternatives and options

Impact	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Operation				
Impact GSSPR-12: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Surface Fault Rupture or Ground Shaking During Operation	Less than significant for both alternatives. Operation of the project would not cause or accelerate the potential for surface fault rupture and would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction because the project would not cause or accelerate the potential for surface fault rupture. However, impacts could occur. The project would not cause the risk of loss, injury, or death beyond what people are currently exposed to in the RSA from fault rupture or round shaking.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-13: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Liquefaction and Other Types of Seismically Induced Ground Failure During Operation	Less than significant for both alternatives. The project design will effectively address risks associated with liquefaction and seismically induced ground failure. Furthermore, project operation would not cause the risk of loss, injury, or death beyond what people are currently exposed to in the RSA from secondary seismic hazards.	No mitigation measures are required	Not applicable	All alternatives and options
Impact GSSPR-14: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Seismically Induced Flooding from Dam Failure or Seiche During Operation	Less than significant for both alternatives. Because the risk of dam failure is low for the project and because the project would not exacerbate seismic conditions, the project would not cause the risk of loss, injury or death beyond what people are currently exposed to in the RSA from the potential for seismically induced dam failure with resulting risk of inundation or seiche.	No mitigation measures are required	Not applicable	All alternatives and options

Impact	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Impact GSSPR-15: Increased Exposure of People or Structures to Potential Loss of Life, Injuries, or Destruction Due to Slope Failure Associated with Cut-and-Fill Slopes, or Landslides, Including Seismically Induced Landslides	Less than significant for both alternatives. Project features will ensure that operation of the project will not increase risks from slope failure hazards, including pre-existing landslides and cut-and-fill slopes, beyond levels of exposure that currently exist.	No mitigation measures are required	Not applicable	All alternatives and Fullerton HSR platform and station facilities

Authority = California High-Speed Rail Authority; BMP = best management practice; Caltrans = California Department of Transportation; CEQA = California Environmental Quality Act; PRMMP = Paleontological Resources Monitoring and Mitigation Plan; PRS = paleontological resources specialist; RSA = resource study area