3.9 Geology, Soils, Seismicity, and Paleontological Resources

Since publication of the Burbank to Los Angeles Project Section Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS), the following substantive changes have been made to this section:

- Two footnotes were added to Section 3.9.2.1 regarding the Federal Railroad Administration's (FRA) new regulations implementing the National Environmental Policy Act (NEPA), which were adopted during the preparation of the Draft EIR/EIS, and the updated Council on Environmental Quality (CEQ) regulations issued after release of the Draft EIR/EIS.
- Text was added to Section 3.9.6.3 and Table 3.9-13 was updated to note the changes in excavation depths for various project components as a result of the engineering and design refinements, including changes to the excavation depths for the Chevy Chase Pedestrian Overcrossing, the relocated switching station, and the relocation of the Superfund extraction wells, valve vaults, and ancillary infrastructure.
- A discussion was added to Section 3.9.6.3 to note that additional paleontologically sensitive geologic units may be impacted by drilling for the relocated extraction wells to depths of up to 225 feet in Glendale and up to 400 feet in Burbank; however, the specific geologic units involved would need to be identified from borings conducted during the subsurface geotechnical testing program at a later design stage.

The revisions and clarifications provided in this section of the Final EIR/EIS do not change the impact conclusions pertaining to geology, soils, seismicity, and paleontological resources presented in the Draft EIR/EIS.

3.9.1 Introduction

Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources (GSSPR), of the EIR/EIS analyzes the potential impacts of the No Project Alternative and the High-Speed Rail (HSR) Build Alternative, and describes impact avoidance and minimization features (IAMF) that would avoid, minimize, or reduce these impacts. Where applicable, mitigation measures are proposed to further reduce, compensate for, or offset impacts of the HSR Build Alternative. This section also defines the geology, soils, and paleontological resources within the region and describes the affected environment in the resource study areas (RSA).

> *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 and tunneling are involved. This section summarizes the geologic materials, paleontological resources, faults, seismic characteristics, and other subsurface conditions of the project.

The *Burbank to Los Angeles Project Section Geology, Soils, and Seismicity Technical Report* (California High-Speed Rail Authority [Authority] 2021a) provides additional technical details for geologic resources and geologic hazards. The *Burbank to Los Angeles Section Paleontological Resources Technical Report* (Authority 2021b) provides additional technical details for paleontological resources. Additional details on GSSPR are provided in the following appendix in Volume 2 of this EIR/EIS:

- Appendix 3.1-B, Regional and Local Policy Inventory

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

- **Section 3.7, Biological and Aquatic Resources**—Construction and operational changes caused by the HSR Build Alternative 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 HSR Build Alternative 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 HSR Build Alternative 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 HSR Build Alternative 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 3.19, Cumulative Impacts**—Construction and operational changes caused by the HSR Build Alternative 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 EIR/EIS.

Geologic Resources

- **Soil Hazards** include expansive soils, erodible soils, and corrosive soils. Expansive soils are susceptible to expansion and contraction resulting from changes in moisture and provide unstable support for foundations or other structures. Erodible soils are susceptible to wind and water erosion. Corrosive soils have chemical properties that weaken concrete or uncoated steel and thereby reduce the design life of the structure.
- **Geologic Hazards** such as slumps and land subsidence pose potential threats to the HSR Build Alternative.
- **Primary Seismic Hazards** include ground surface fault ruptures and ground shaking. 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 is the level of ground movement caused by a seismic event.
- **Secondary Seismic Hazards** include liquefaction, seismically induced settlements, lateral spreads or slumps, and flooding resulting from seismically induced dam failure. Liquefaction is a type of ground failure in which soils lose their strength as a result of buildup in pore water pressure during and immediately following ground shaking.
- **Areas of Difficult Excavation** are defined as excavation methods that require more than standard earth-moving equipment or special controls to enable work to proceed.
- **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** 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 particular 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 shed light on environmental change over time.

3.9.2 Laws, Regulations, and Orders

This section describes the federal, state, and local laws, regulations, orders, and plans applicable to GSSPR.

3.9.2.1 Federal

The National Environmental Policy Act of 1969, as amended (42 U.S. Code §4321 et seq.)

As with cultural resources, the NEPA recognizes the continuing responsibility of the federal government to "preserve important historic, cultural, and natural aspects of our national heritage" (Sec. 101 [U.S. Code (U.S.C.) Title 42, § 4321]). 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 all 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 any proposed federal agency action. General NEPA procedures are set forth in the CEQ regulations (Code of Federal Regulations [C.F.R.] Title 40, Parts 1500–1508).[1,2]

Federal Railroad Administration, Procedures for Considering Environmental Impacts (64 Fed. Reg. 28545)

On May 26, 1999, the FRA released *Procedures for Considering Environmental Impacts* (FRA 1999). These FRA procedures supplement the CEQ Regulations and describe FRA's process for assessing the environmental impacts of actions and legislation proposed by the agency and for the preparation of associated documents. 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." These FRA procedures state that an EIS should consider possible impacts on geology, soils, seismicity, and paleontology.

American Antiquities Act of 1906 (16 U.S.C § 431–433)

The American Antiquities Act was enacted with the primary goal of protecting cultural resources in the U.S. As such, it prohibits appropriation, excavation, injury, or destruction of "any historic or prehistoric ruin or monument, or any object of antiquity" located 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 C.F.R. 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.

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.

[1] While this EIR/EIS was being prepared, FRA adopted new NEPA compliance regulations (23 C.F.R. 771). Those regulations only apply to actions initiated after November 28, 2018. See 23 C.F.R. 771.109(a)(4). Because this EIR/EIS was initiated prior to that date, it remains subject to FRA's Environmental Procedures rather than the Part 771 regulations.

[2] The CEQ issued new regulations on July 14, 2020, effective September 14, 2020, updating the NEPA implementing procedures at 40 C.F.R. Parts 1500-1508. However, this project initiated NEPA before the effective date and is not subject to the new regulations, relying on the 1978 regulations as they existed prior to September 14, 2020. All subsequent citations to CEQ regulations in this environmental document refer to the 1978 regulations, pursuant to 40 C.F.R. 1506.13 (2020) and the preamble at 85 Fed. Reg. 43340.

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.

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 Division of Oil, Gas and Geothermal Resources (DOGGR) within the Department of Conservation oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal wells. DOGGR'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.

California Environmental Quality Act (California Public Resources Code, Section 21000 et seq.) and California Environmental Quality Act Guidelines Protection for Paleontological Resources

The California Environmental Quality Act (CEQA) statute includes "objects of historic … significance" in its definition of the environment (CEQA § 21060.5), and Section 15064.5 of the State CEQA Guidelines further defines historical 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 CEQA statute nor the Guidelines provide explicit direction regarding the treatment of paleontological resources.

California Public Resources Code

The California Public Resources Code (PRC) also protects paleontological resources in specific contexts. In particular, PRC Section 5097.5 prohibits "knowing and willful" excavation, removal, destruction, injury, and defacement of any 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 (PRC § 5097.5(c)), and persons convicted of such a violation may also be required to provide restitution (PRC § 5097.5(d)(1)). Additionally, PRC 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

Table 3.9-1 and Table 3.9-2 list county and city general plan goals, policies, and ordinances relevant to GSSPR.

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

Policy/Goal/Objective Title	Summary
Los Angeles County	
Los Angeles County General Plan 2035	The County of Los Angeles adopted the *Los Angeles County General Plan 2035* on October 6, 2015. The General Plan includes the following goals and policies relevant to geology, soils, and seismicity: ▪ Safety Element, Geotechnical Hazards, Goal S 1: Prevent or minimize personal injury, loss of life and property damage due to seismic and geotechnical hazards. ▪ Safety Element, Policy S 1.1: Discourage development in Seismic Hazard and Alquist-Priolo Earthquake Fault Zones. ▪ Safety Element, Policy S 1.2 Prohibit the construction of most structures for human occupancy adjacent to active faults until a comprehensive fault study that addresses the potential for fault rupture has been completed. ▪ Safety Element, 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. ▪ Safety Element, Policy S 1.4: Support the retrofitting of unreinforced masonry structures to help reduce the risk of structural and human loss due to seismic hazards. ▪ Conservation Element, 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	The Los Angeles County Code is codified through Ordinance 2016-0039F and was updated November 18, 2016. ▪ 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 Burbank	
City of Burbank General Plan Safety Element (2013)	The Safety Element satisfies the requirements of state planning law and is a mandated component of the Burbank2035 General Plan. Section 65302(g) of the California Government Code sets forth the following list of hazards that the element must cover, if these hazards pertain to conditions in the city: seismically induced conditions, including ground shaking, surface rupture, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction, and other geologic hazards; flooding; wildland and urban fires; and evacuation routes.
City of Burbank Code	The City of Burbank Grading Code is based on Appendix J of the CBC. Local amendments to the CBC are found in Title 9, Chapter 1, of the Burbank Municipal Code.
City of Glendale	
City of Glendale General Plan Land Use Element (1986)	The Land Use Element designates the proposed general distribution and general location and extent of the uses of the land within the city. It includes geographic and geologic restrictions.
City of Glendale General Plan Safety Element (2003)	The Safety Element describes the natural conditions that pose a hazard (i.e., fire, earthquakes, flooding, and other geologic hazards) and presents goals, policies, and programs that, if implemented, can reduce the risk these hazards pose to the City of Glendale and its residents.
City of Glendale Code	The grading code for the City of Glendale is found in Title 15 (Building and Construction), Chapter 15.12 (Hillside Areas and Excavation Blasting) of the City of Glendale Municipal Code.

Policy/Goal/Objective Title	Summary
City of Los Angeles	
City of Los Angeles General Plan Safety Element (1996)	The Safety Element addresses natural hazards associated with fire, flood, earthquake, and landslides, as well as other hazards generally associated with or compounded by natural events. The intent of the plan is to reduce deaths, injuries, property damage, and economic and social dislocation resulting from natural hazards.
City of Los Angeles Code	The City of Los Angeles Building Code is based on the CBC, which is based on the International Building Code; however, certain pages of the CBC are replaced by the City of Los Angeles codes.

CBC = California Building Code
HMA = Hillside Management Area

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

Policy/Goal/Objective Title	Summary
Los Angeles County	
Los Angeles County General Plan Conservation and Natural Resources Element (2012)	Goal C/NR 14: Paleontological resources. 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 the County's historic, cultural, and paleontological resources. Policy C/NR 14.5. Promote public awareness of the County's historic, cultural, and paleontological resources. Policy C/NR 14.6. Ensure proper notification and recovery processes are carries out for development on or near historic, cultural, and paleontological resources.
City of Burbank	
City of Burbank General Plan Open Space and Conservation Element (2013)	Policy 6.1: Recognize and maintain paleontological structure and sites essential for community life and identity. Program OSC-7: Implement the following actions during development review and the CEQA review process to achieve Open Space and Conservation Element goals and policies. If paleontological resources are discovered during earthmoving activities associated with future development projects, the construction crew shall immediately cease work in the vicinity of the find and notify the City. The project applicant(s) shall retain a qualified paleontologist to evaluate the resource and prepare a recovery plan in accordance with Society of Vertebrate Paleontology guidelines ([2010]). The recovery plan shall include, but is not limited to, a field survey, construction monitoring, sampling and data recovery procedures, museum storage coordination for any specimen recovered, and a report of findings. Recommendations in the recovery plan that are determined by the lead agency to be necessary and feasible shall be implemented before construction activities can resume at the site where paleontological resources were discovered.
City of Glendale	
City of Glendale General Plan Open Space and Conservation Element (1993)	Policy 3: Paleontological structures and sites are essential to community life and identity and should be recognized and maintained.

Policy/Goal/Objective Title	Summary
City of Los Angeles	
City of Los Angeles General Plan Conservation Element (2001)	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.

CEQA = California Environmental Quality Act

3.9.3 Consistency with Plans and Laws

As indicated in Section 3.1, Introduction, CEQA and NEPA regulations[3] require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws.

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 federal and state agency proposing to construct and operate the HSR system, is required to comply with all federal and state laws and regulations and to secure all applicable federal and state permits prior to initiating construction of the project. Therefore, there would be no inconsistencies between the HSR Build Alternative and these federal and state laws and regulations.

The Authority is a state agency and therefore is not required to comply with local land use and zoning regulations; however, it has endeavored to design and construct the HSR project so that it is consistent with land use and zoning regulations. A total of 4 plans and 13 policies were reviewed. The HSR Build Alternative would be consistent with all of the plans and policies reviewed that were applicable to GSSPR.

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

[3] NEPA regulations refer to the regulations issued by the Council for Environmental Quality at 40 C.F.R. Part 1500.

3.9.4 Methods for Evaluating Impacts

The following sections summarize the RSAs and the methods used to analyze impacts on geology, soils, and paleontological resources and from seismicity. As summarized in Section 3.9.1, Introduction, five other sections also provide additional information related to GSSPR: 3.7, Biological Resources and Wetlands; 3.8, Hydrology and Water Resources; 3.10, Hazardous Materials and Wastes; Section 3.11, Safety and Security; and Section 3.19, Cumulative Impacts.

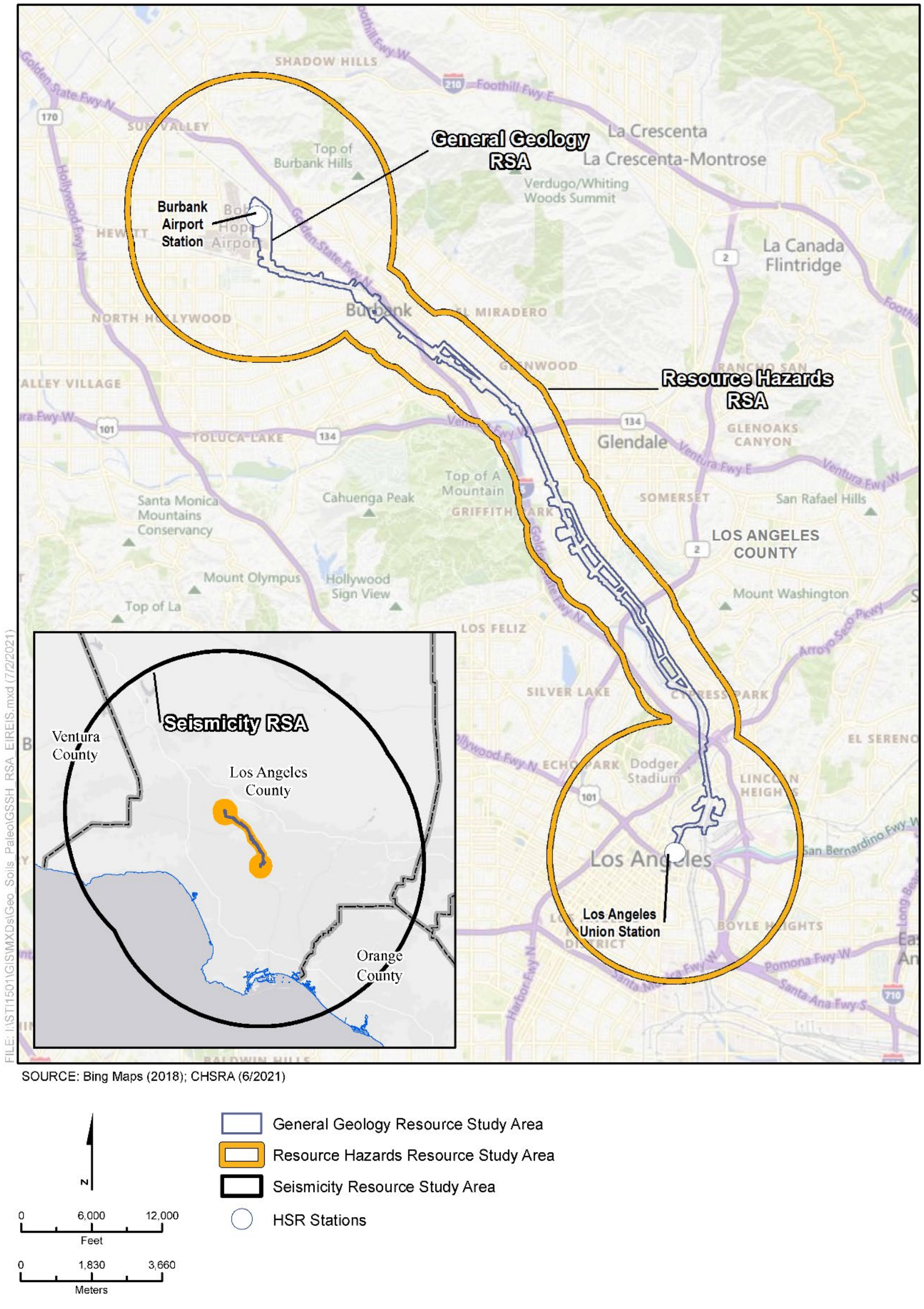
3.9.4.1 Definition of Resource Study Area

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 all resource topics included in geology, soils, seismicity, and paleontological resources extend beyond the project footprint and also extend into the subsurface beneath the project footprint. The concept of the RSA is applied slightly differently for geology, soils, and seismicity effects than for paleontological resources effects. The basis for defining the types of geology, soils, seismicity, and paleontological resources 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 Burbank to Los Angeles Project Section. Figure 3.9-1 shows the geology, soils, and seismicity RSAs, and Figure 3.9-2 shows the paleontological resources RSA.

Table 3.9-3 Definition of Resource Study Areas

General Definition	Resource Study Area Boundary and Definition
Geology, Soils, and Seismicity	
General Geology	Project footprint plus a 150-foot buffer around surface portions of the HSR Build Alternative and a 200-foot buffer around below-grade portions of the HSR Build Alternative.
Resource Hazards (e.g., expansive soils, corrosive soils, soil failures, settlement, corrosivity, shrink-swell, erosion, earthquake-induced liquefaction risks, subsidence, subsurface gas hazards, mineral resource extraction, and oil and gas wells)	Project footprint plus a 0.5-mile buffer along the HSR Build Alternative alignment with the buffer increasing to 2 miles around station sites.
Seismicity	Project footprint plus 30-mile buffer around alignment
Paleontological Resources	
Paleontological Resources	Project footprint plus a 150-foot buffer and the vertical extent of the geologic units below the horizontal RSA which HSR Build Alternative construction or operation may encounter.

HSR = high-speed rail
RSA = resource study area



SOURCE: Bing Maps (2018); CHSRA (6/2021)

Figure 3.9-1 General Geology, Resource Hazards, and Seismicity Resource Study Areas

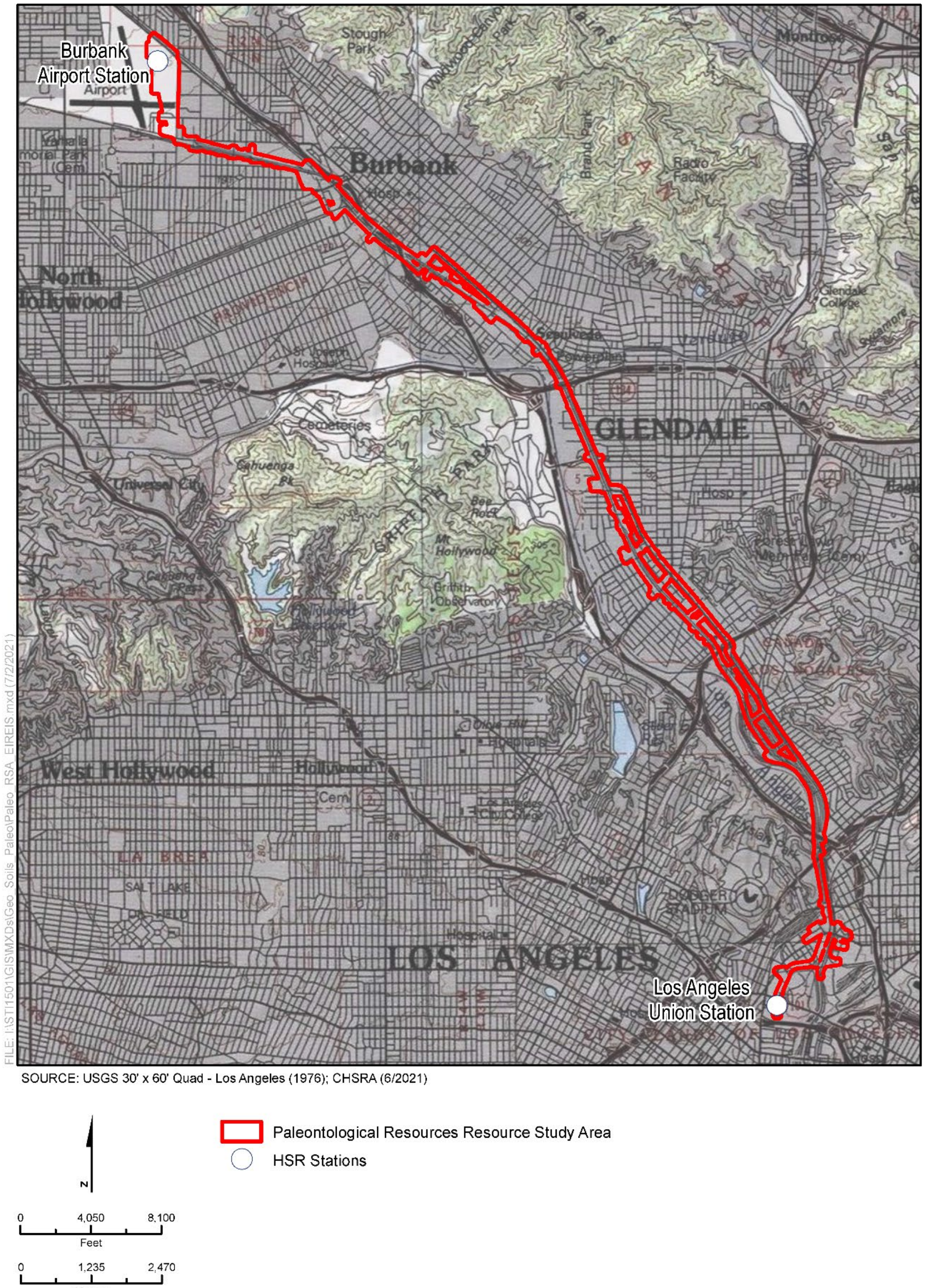


Figure 3.9-2 Paleontological Resources Resource Study Area

3.9.4.2 Impact Avoidance and Minimization Features

The HSR Build Alternative incorporates standardized HSR features to avoid and minimize impacts. These features are referred to as IAMFs. The Authority would implement IAMFs during project design and construction. As such, the analysis of impacts of the HSR Build Alternative in this section factors in all applicable IAMFs. Appendix 2-B, Impact Avoidance and Minimization Features, provides a detailed description of IAMFs that are included as part of the HSR Build Alternative design. IAMFs applicable to GSSPR include:

- GEO-IAMF#1, Geologic Hazards—Preparing a Construction Management Plan (CMP) that would address geological and geotechnical constraints and resources. This includes groundwater withdrawal, unstable soils, subsidence, wind and water erosion, soils and shrink-swell potential, soils with corrosive potential, and a health and safety plan.
- GEO-IAMF#2, Slope Monitoring—During operations and maintenance, monitoring slopes at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading.
- GEO-IAMF#3, Gas Monitoring—Preparing a CMP addressing how gas monitoring would be incorporated into construction BMPs.
- GEO-IAMF#4, Historic or Abandoned Mines and Other Toxic Sites—Preparing a CMP addressing how historic or abandoned mines and other toxic sites would be incorporated into construction BMPs.
- GEO-IAMF#5, Hazardous Minerals, soils, or vapors—Preparing a CMP addressing how the contractor would minimize or avoid impacts related to hazardous minerals (i.e., radon, mercury, tetrachloroethylene, trichloroethylene, and naturally occurring asbestos), soils, or vapors during construction.
- GEO-IAMF#6, Ground Rupture Early Warning Systems—Preparing a technical memorandum documenting how the project design incorporates installation of early warning systems triggered by strong ground motion association with ground rupture.
- GEO-IAMF#7, Evaluate and Design for Large Seismic Ground Shaking—Preparing a technical memorandum documenting how all HSR components were evaluated and designed for large seismic ground shaking.
- GEO-IAMF#8, Suspension of Operations during an Earthquake—Preparing a technical memorandum documenting how suspension of operations during or after an earthquake was addressed in project design.
- GEO-IAMF#9, Subsidence Monitoring—Developing and implementing a stringent track monitoring program that would monitor the effects of ongoing subsidence to provide early warning of reduced track integrity.
- GEO-IAMF#10, Geology and Soils—Preparing 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—Retaining 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—For each CP within the project section, evaluating the 90 percent design submittal to identify the portions of the CP that would involve work in paleontologically sensitive geologic units, in consideration of the final Paleontological Resources Technical Report prepared for the project section. 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—Developing a CP-specific PRMMP incorporating the Final Design Review and triggering evaluation for each CP.
- GEO-IAMF#14, Provide Worker Environmental Awareness Program Training for Paleontological Resources—Providing paleontological resources Worker Environmental Awareness Program training to all 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—Ceasing all activity in the immediate vicinity of known or potential fossil materials discovered during construction in order to protect the find from further disturbance.
- HYD-IAMF#3, Prepare and Implement a Construction Stormwater Pollution Prevention Plan—Prior to construction (any ground-disturbing activities), the contractor shall comply with the State Water Resources Control Board Construction General Permit requiring preparation and implementation of a Stormwater Pollution Prevention Plan.
- SS-IAMF#4, Oil and Gas Wells—Prior to construction, identify and inspect all active and abandoned oil and gas wells within 200 feet of the HSR Build Alternative. Abandon and relocate any active wells and re-abandon, as necessary, any abandoned wells in accordance with the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources standards.

3.9.4.3 Methods for NEPA and CEQA Impact Analysis

This section describes the sources and methods the Authority used to analyze potential impacts from implementing the HSR Build Alternative on geology, soils, seismicity, and paleontological resources. These methods apply to both NEPA and CEQA 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. Refer to the *Burbank to Los Angeles Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2021a) for information regarding the methods and data sources used in this analysis. Laws, regulations, and orders (Section 3.9.2, Laws, Regulations, and Orders) that regulate geology, soils, paleontological resources, and seismicity were also considered in the evaluation of impacts on geology, soils, and paleontological resources and from seismicity.

Analysts used the following methods to evaluate potential direct and indirect impacts from construction and operations on geology, soils, and paleontological resources, as well as impacts on construction and operations from existing geologic conditions, including seismicity.

Geology, Soils, and Seismicity

The following methods were used to evaluate potential impacts the HSR Build Alternative could have on geology and soils, as well as impacts on HSR Build Alternative construction and operations that could result from existing geologic conditions, including seismicity.

To establish the baseline for the analysis (existing conditions), the geologic setting, seismicity, minerals resources, and energy resources (oil and natural gas) are identified. The setting also includes risks such as primary and secondary seismic hazards, and unstable slopes and soils.

This analysis used information from publicly available sources such as the U.S. Geological Survey (USGS), the California Geological Survey (CGS; formerly known as California Division of Mines and Geology), the California Department of Transportation (Caltrans), the California Department of Water Resources, local planning departments, and published geologic reports and maps. The following geologic, soils, and seismic hazards are discussed:

- Surface rupture along hazardous faults
- Ground shaking
- Liquefaction and other seismically induced ground deformations
- Surface water and groundwater

- Flooding and dam inundation
- Tsunami and seiche
- Static and seismically induced landslides
- Erosion and scour
- Land subsidence
- Collapsible and unstable soils
- Expansive soils
- Corrosive soils
- Mineral resources
- Oil and natural gas resources

Refer to the *Burbank to Los Angeles Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2021a) for more information regarding the methods and data sources used in this analysis.

Paleontological Resources

The methodology used to describe the affected environment and evaluate the potential environmental impacts of the HSR Build Alternative on paleontological resources involves identification of the geologic units that are present within the surface and, to the extent possible, the subsurface of the paleontological resources RSA. Background research is then conducted to determine the potential for each geologic unit within the paleontological resources RSA to produce paleontological resources, as well as the scientific importance of those resources. An analysis of the preliminary design plans then determines the type, degree, and extent of the HSR Build Alternative's impacts on any potential resources.

Relevant geologic maps, geological and paleontological literature, and technical reports were reviewed to determine what geologic units are present within the paleontological resources RSA and whether fossils have been recovered from those or similar geologic units elsewhere in the region. Geologic units may extend over large geographic areas and contain similar lithologies (lithologies are the physical characteristics of rocks [e.g., grain size, texture, color, and composition]) and fossils. Therefore, the literature review includes areas with the same or similar geologic units outside the paleontological resources RSA because fossils found in the same or similar deposits elsewhere in the region demonstrate the potential to find fossils during development of the HSR Build Alternative. For the purposes of this analysis, the region includes most of Southern California to the extent necessary to demonstrate paleontological sensitivity, including the Los Angeles Basin and the Inland Empire because enough fossil material has been recovered from this region to demonstrate paleontological sensitivity.

In March 2016, a locality search was conducted through the Natural History Museum of Los Angeles County (LACM). This search identified any vertebrate localities in the LACM records that are known from the paleontological resources RSA or from the same or similar deposits as those mapped in the paleontological resources RSA. The purpose of a locality search is to establish the status and extent of previously recorded paleontological resources within the paleontological resources RSA and within the same or similar deposits as those mapped within the paleontological resources RSA.

A field inspection was also conducted to identify any unrecorded paleontological resources and note the sediments exposed at the surface. In this way, impacts to existing, unrecorded paleontological material may be mitigated prior to the beginning of ground-disturbing activities, and portions of the paleontological resources RSA that are more likely to contain paleontological resources may be identified. The field inspection included open and accessible areas of public right-of-way (e.g., parks and areas along streets or intersections), but access to private property was not available.

The paleontological resources impact analysis was prepared consistent with the methods presented in the Society of Vertebrate Paleontology (SVP) *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (SVP 2010) and Caltrans *Standard Environmental Reference*, *Environmental Handbook Vol. 1, Chapter 8 Paleontology* (Caltrans

2014). The *Burbank to Los Angeles Project Section: Paleontological Resources Technical Report* (Authority 2021b) provides a detailed description of the evaluation methods.

There are four steps in analyzing a project's potential to impact paleontological resources:

1. Identify the geologic units in the paleontological resources RSA
2. Evaluate the potential of identified geologic units to contain significant fossils (their paleontological potential or paleontological sensitivity)
3. Assess the nature and extent of potential effects from project construction and operation based on the type and extent of ground disturbing activity within paleontologically sensitive geologic units
4. Evaluate impact significance

According to the SVP (2010), paleontological sensitivity is the potential for the presence of scientifically significant, nonrenewable paleontological resources. All sedimentary rocks, some volcanic rocks, and some metamorphic rocks have potential for the presence of scientifically significant, nonrenewable paleontological resources, and review of available literature would further refine the potential of each geologic unit, formation, or facies. The SVP has four categories of potential, or sensitivity: High, Low, None, and Undetermined. If a geographic area or geologic unit is classified as having undetermined potential for paleontological resources, studies must be undertaken to determine whether that geologic unit has a sensitivity of either High, Low, or None. These categories are described in more detail in Table 3.9-4. Refer to the *Burbank to Los Angeles Project Section: Paleontological Resources Report* (Authority 2021b) for more information regarding the methods and data sources used in this analysis.

Table 3.9-4 Society of Vertebrate Paleontology Sensitivity Categories

Rating	Description
High Potential (high sensitivity)	Geologic units from which vertebrate or scientifically significant invertebrate, plant, or trace fossils have been recovered are considered to have a high potential for containing additional scientifically significant paleontological resources. Rocks units classified as having high potential for producing paleontological resources include, but are not limited to: ▪ Sedimentary formations and some volcaniclastic formations (e.g., ashes or tephras) ▪ Some low-grade metamorphic rocks that contain scientifically significant paleontological resources anywhere within their geographical extent ▪ Sedimentary geologic units temporally or lithologically suitable for the preservation of fossils (e.g., middle Holocene and older, fine-grained fluvial sandstones, argillaceous and carbonate-rich paleosols, cross-bedded point bar sandstones, fine-grained marine sandstones) Paleontological potential consists of both: a. The potential for yielding abundant or scientifically significant vertebrate fossils or for yielding a few scientifically significant fossils, large or small, vertebrate, invertebrate, plant, or trace fossils b. The importance of recovered evidence for new and scientifically significant taxonomic, phylogenetic, paleoecologic, taphonomic, biochronologic, or stratigraphic data Geologic units that contain potentially datable organic remains older than late Holocene (including deposits associated with animal nests or middens) and geologic units that may contain new vertebrate deposits, traces, or trackways are also classified as having high potential.
Low Potential (low sensitivity)	Geologic units that have a low potential for yielding scientifically significant fossils would be those poorly represented by fossil specimens in institutional collections or (based on general scientific consensus) those where fossils are only preserved in rare circumstances. Thus, for low-potential geologic units, the presence of fossils is the exception, not the rule (e.g., basalt flows or recent colluvium). Geologic units with low potential typically will not require impact mitigation measures to protect fossils.

Rating	Description
No Potential (not sensitive)	Some geologic units have no potential to contain scientifically significant paleontological resources (e.g., high-grade metamorphic rocks [such as gneisses and schists] and plutonic igneous rocks [such as granites and diorites]). Geologic units with no potential require no protection or impact mitigation measures relative to paleontological resources.
Undetermined Potential	Geologic units for which little information is available concerning their paleontological content, geologic age, and depositional environment are considered to have undetermined potential. Further study is necessary to determine whether these geologic units have high or low potential to contain scientifically significant paleontological resources. A field survey by a qualified professional to specifically determine the paleontological resource potential of these geologic units is required before a Paleontological Resources Impact Mitigation Program can be developed. In cases where no subsurface data are available, paleontological potential can sometimes be determined by strategically located excavations into subsurface stratigraphy.

Source: Society of Vertebrate Paleontology, 2010
Taxonomic = related to the classification of animals, plants, or other organisms
Phylogenetic = related to the evolution and diversification of animals, plants, or other organisms
Paleoecologic = related to the interactions of ancient life forms and their environment
Taphonomic = related to how an animal, plant, or other organism becomes a fossil
Biochronologic = related to the correlation in time of biological events using fossils
Stratigraphic = related to the study of rock layers (e.g., their distribution, deposition, correlation, and age)

3.9.4.4 Method for Determining Significance under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (State CEQA Guidelines § 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a significance determination for each impact using a threshold-based analysis (see Section 3.1.5.4, Methods for Evaluating Impacts, for further information). By contrast, under NEPA, significance is used to determine whether an EIS will be required; NEPA requires that an EIS be prepared when the proposed federal action (project) as a whole has the potential to "significantly affect the quality of the human environment." Accordingly, Section 3.9.9, California Environmental Quality Act Significance Conclusions, summarizes the significance of the environmental impacts on geology, soils, and paleontological resources and from seismicity for the HSR Build Alternative. The Authority is using the following thresholds to determine if a significant impact on geology, soils, and paleontological resources and from seismicity would occur as a result of the HSR Build Alternative.

Geology, Soils, and Seismicity

Based on the CEQA Guidelines, a project would have a significant impact related to geology, soils, and seismicity if it:

- Directly or indirectly causes potential 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 due to seismic activity or its related hazards, including fault rupture,[4] ground shaking, ground failure including liquefaction, dam failure, seiche or tsunami, and landslides
- Results 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
- Is located on a geologic unit or soil that is unstable or that renders a currently stable geologic unit or soil unstable to a degree that would result in increased exposure of people to loss of life or structures to destruction due to geologic hazards, such as primary and secondary seismic hazards

[4] 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 project area. Refer to Division of Mines and Geology Special Publication 42.

- Is constructed on expansive 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) creating substantial direct or indirect risks to life or property
- Makes 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
- Results in the loss of availability of a locally important mineral resource recovery site
- Is located in an area of subsurface gas hazard, including landfill gas, and provides a route of exposure to that hazard that results in a substantial risk of loss of life or destruction of property

Paleontological Resources

A significant impact on paleontological resources is one that would directly or indirectly destroy a unique paleontological resource or site.

3.9.5 Affected Environment

This section describes the geology, soils, seismicity, and paleontological resources in the respective RSAs, including geology, soils, geologic hazards, primary seismic hazards, secondary seismic hazards, areas of difficult excavation, geologic resources, and paleontological 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.

3.9.5.1 Geology, Soils, and Seismicity

Physiography and Regional Geologic Setting

The physiography and regional geologic setting is consistent for geology, soils, and seismicity, and paleontological resources. These two disciplines would therefore be considered together here.

The RSAs for geology, soils, and seismicity and paleontological resources have their northern termini in the eastern end of the San Fernando Valley, pass along the eastern side of the Elysian Park Hills, and have their southern termini in the Los Angeles Basin). These RSAs are located in the transition zone between the south-central part of the Transverse Ranges Geomorphic Province and the northern end of the Peninsular Ranges Geomorphic Province of California.

Transverse Ranges Geomorphic Province

The Transverse Ranges Geomorphic Province is characterized by steep mountains and valleys that trend in an east-west direction at an oblique angle to the northwest-southeast trend of the California coast (Dibblee 1982; Norris and Webb 1976), hence the name “Transverse.” This type of trend is extremely rare elsewhere in the U.S. (Dibblee 1982; Yerkes and Campbell 2005). Compression along the San Andreas fault is squeezing and rotating the Transverse Ranges, making this area one of the most rapidly rising regions on earth (CGS 2002; Dibblee 1982; Jackson and Molnar 1990; Morton and Yerkes 1987; Nicholson et al. 1994). Tectonic activity in this province has also folded and faulted thick sequences of Cenozoic, organic-rich sedimentary rocks, making the area an important source for oil (Biddle 1991; Redin 1991; Yerkes et al. 1965).

Peninsular Ranges Geomorphic Province

The Peninsular Ranges Geomorphic Province is a 900-mile long northwest-southeast trending structural block that extends from the Transverse Ranges in the north to the tip of Baja California in the south and includes the Los Angeles Basin (Norris and Webb 1976). This province is characterized by mountains and valleys that trend in a northwest-southeast direction, roughly parallel to the San Andreas Fault Zone (Norris and Webb 1975; Sharp 1976). The total width of the province is approximately 225 miles, extending from the Colorado Desert in the east, across the continental shelf, to the Southern Channel Islands (i.e., Santa Barbara, San Nicolas, Santa Catalina, and San Clemente) (Sharp 1976). The province contains extensive pre-Cenozoic (more than 66 million years ago) igneous and metamorphic rocks that are covered by a veneer of Cenozoic (66 million years ago to present) sedimentary deposits in many places (Norris and Webb 1976; Wright 1991).

Geology

The San Fernando Valley is a large structural trough bordered by the San Gabriel Mountains to the north and east, and the Santa Monica Mountains, Hollywood Hills, and Elysian Park Hills to the south (Yerkes 1997). The valley has been filled by sediment carried down the drainages of the surrounding hills and mountains and contains the headwaters of the Los Angeles River (Yerkes 1997). The basement of this valley is composed of igneous and metamorphic rocks that range in age from approximately 1.7 billion years ago to 66 million years ago (Yerkes 1997, Yerkes et al. 1965). Overlying these basement rocks are thousands of feet of Cenozoic marine and terrestrial deposits that have accumulated in this area as the depositional environment shifted from a series of forearc basins, to rifted basins, to a larger offshore basin and coastal environment that extended from what is now Ventura County down to Orange County (Wright 1991; Yerkes 1997; Yerkes et al. 1965).

The broad alluvial lowland that forms the current Los Angeles Basin is bounded by the San Gabriel Mountains to the north, the Santa Ana Mountains to the east, and the Pacific Ocean to the southwest (Yerkes et al. 1965). As with the San Fernando Valley, the current Los Angeles Basin is underlain by a structural depression that has discontinuously accumulated thousands of feet of marine and terrestrial deposits since the Late Cretaceous (approximately 100.5 million years ago) (Wright 1991; Yerkes et al. 1965). Over millions of years, the basin has experienced episodes of subsidence, deposition, uplift, erosion, prolific sources of crude oil (Biddle 1991; Bilodeau et al. 2007; Wright 1991; Yerkes et al. 1965). The modern surface of the basin slopes gently southwestward toward the Pacific Ocean, interrupted in various places by low hills, such as the Elysian Hills bordering the RSA (Wright 1991; Yerkes et al. 1965). The basin is also traversed by several large rivers (Sharp 1976; Yerkes et al. 1965), including the Rio Hondo, the San Gabriel River, the Santa Ana River, and the Los Angeles River. The RSA parallels the Los Angeles River along part of its length. The low relief of the basin is primarily due to the coalesced floodplains and alluvial fans of the Santa Ana River and San Gabriel River (Yerkes et al., 1965).

According to the geologic map prepared by Yerkes and Campbell (2005), four geologic units may be encountered within the general geology and paleontological resources RSAs. These geologic units include Artificial Fill; Holocene Alluvial Fan Deposits; Holocene and late Pleistocene Young Alluvial Fan Deposits, undivided; and the late Miocene Puente Formation (Figure 3.9-3 [Sheets 1 through 3]). Abbreviated unit descriptions of geologic units within the general geology RSA are summarized in Table 3.9-5.

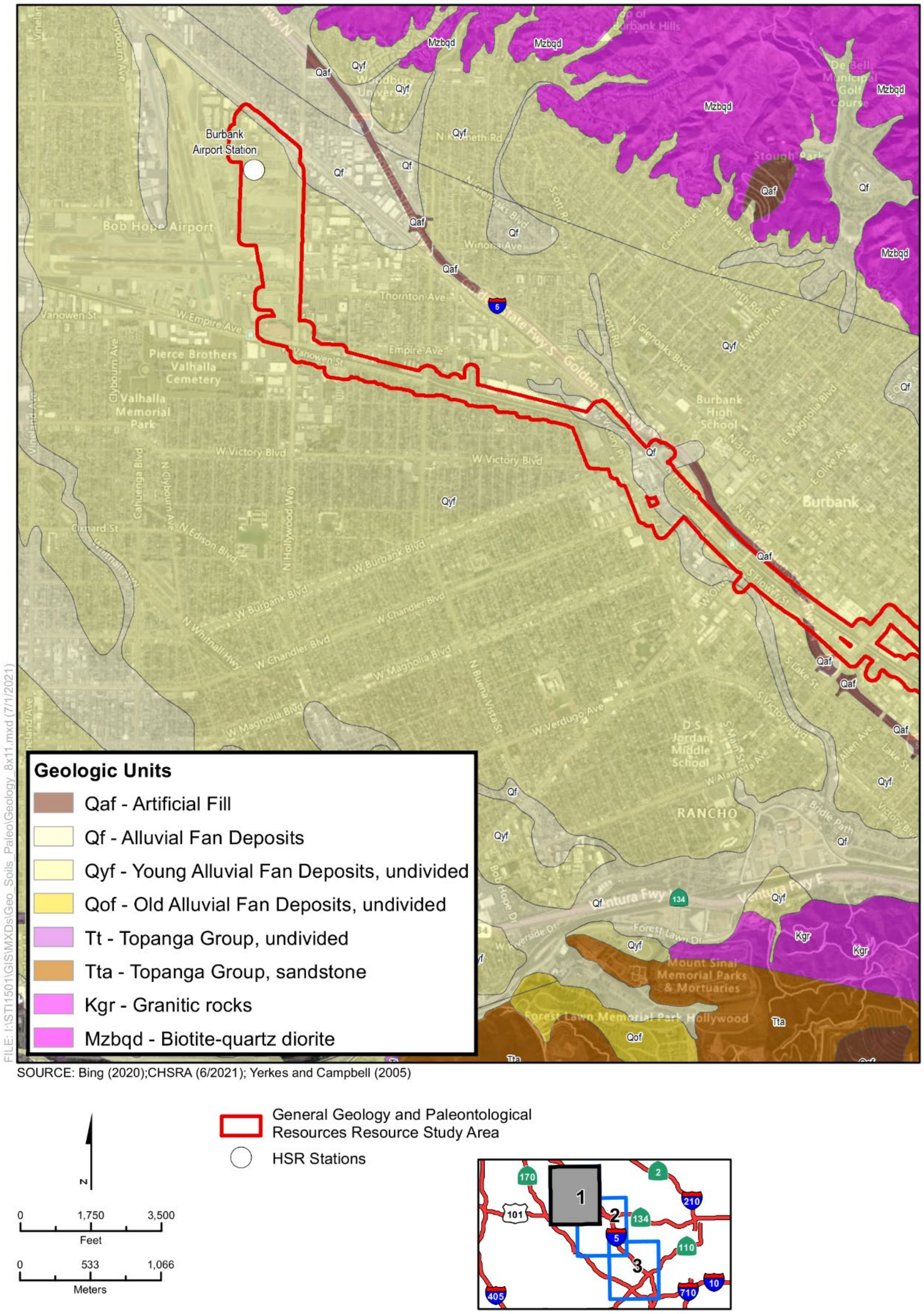
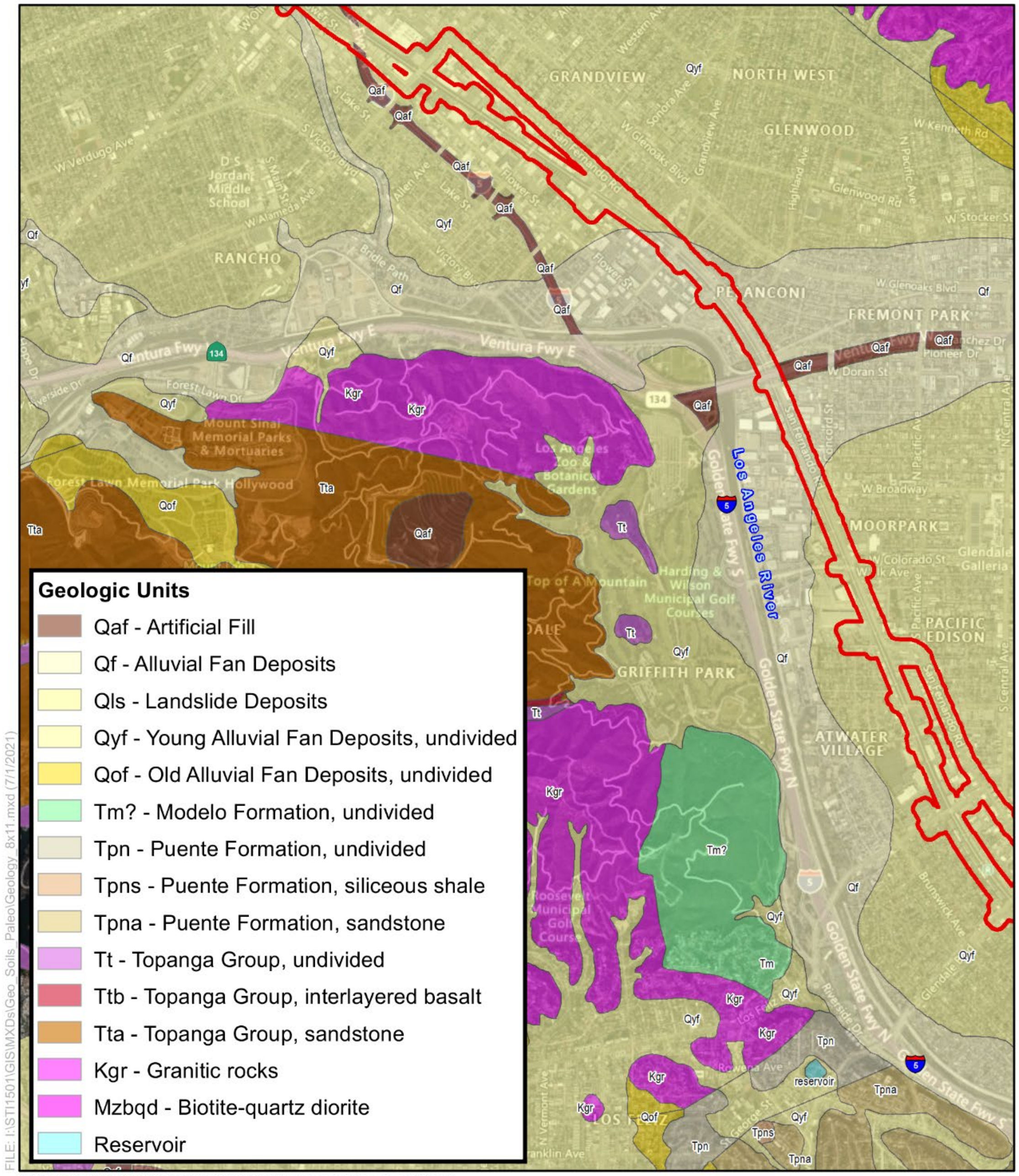


Figure 3.9-3 Geologic Units in the General Geology and Paleontological Resources Resource Study Areas

(Sheet 1 of 3)



SOURCE: Bing (2020);CHSRA (6/2021); Yerkes and Campbell (2005)

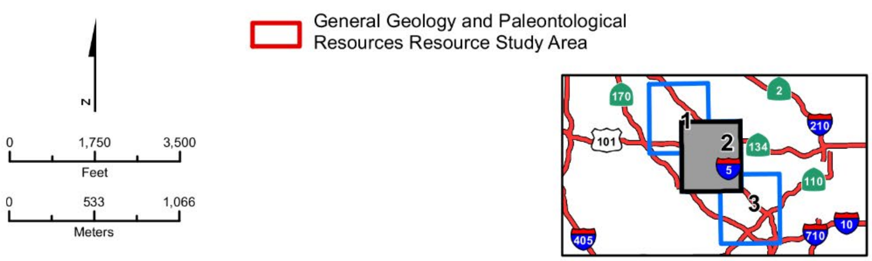


Figure 3.9-3 Geologic Units in the General Geology and Paleontological Resources Resource Study Areas

(Sheet 2 of 3)

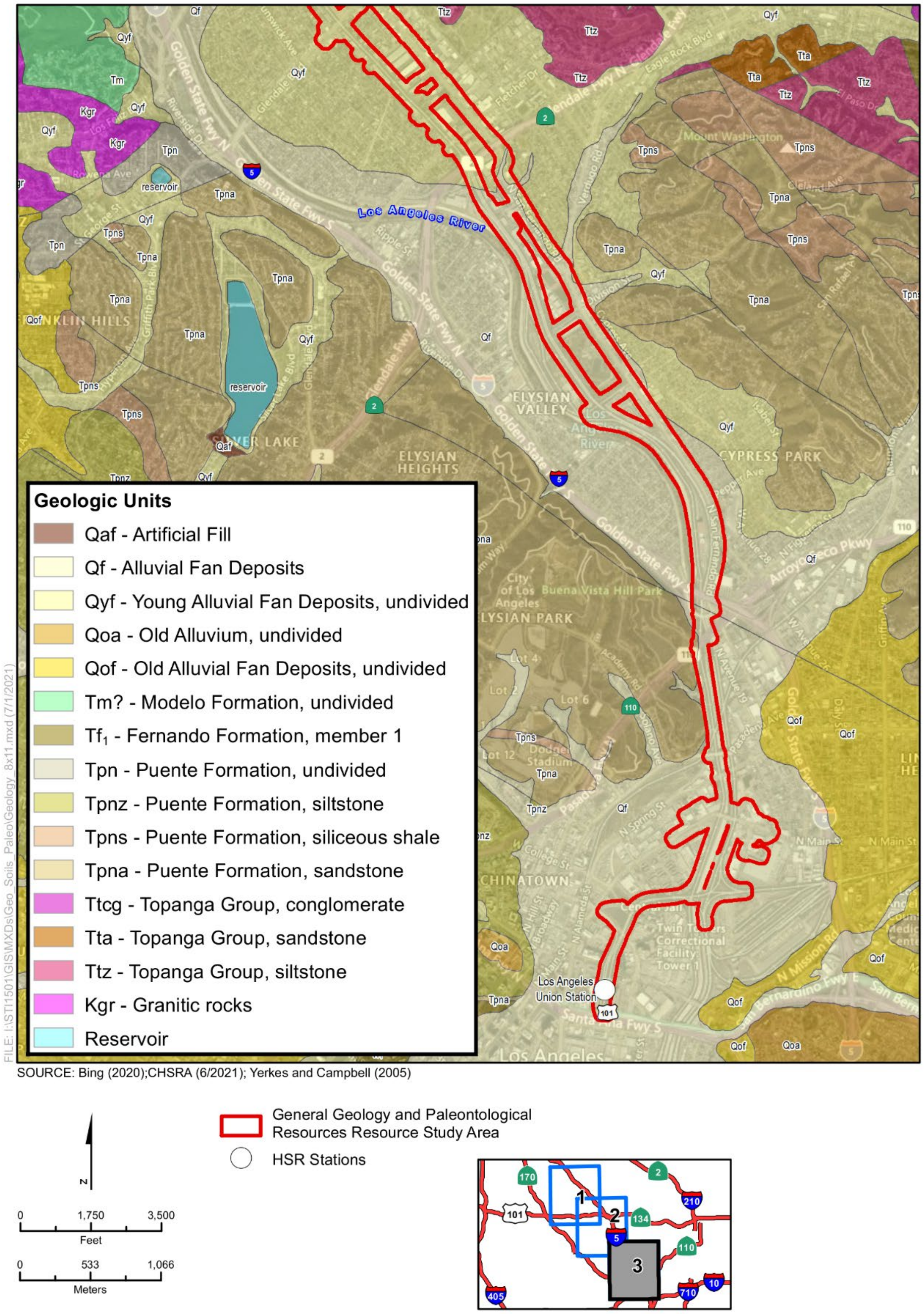


Figure 3.9-3 Geologic Units in the General Geology and Paleontological Resources Resource Study Areas

(Sheet 3 of 3)

Table 3.9-5 Summary of Geologic Units within the General Geology and Paleontological Resources Resource Study Area

Map Symbol	Description
Af	Artificial fill extends along I-5 (Golden State Freeway) (CGS 1997, 1998). Other fill materials likely exist in areas scattered across the San Fernando Valley and the Los Angeles region; therefore, even though not shown on published maps, these materials potentially exist to some extent in the general geology RSA. These fills may be engineered and compacted to modern standards or may be undocumented with unknown properties. In general, it can be expected that the engineered fill materials would be predominantly sand, silt, and fine gravel due to the ease of compaction. Locally present undocumented fills may contain larger materials (e.g., cobble and boulders) and trash (e.g., organic matter, metal, concrete, and wood).
Qf	The Qf deposits extend into the San Fernando Valley from the larger canyons to the north and east of the general geology RSA (e.g., the Pacoima and Tujunga canyons, respectively). The map view of these deposits is typically an irregular linear ribbon, some of which is mapped near the proposed Burbank Airport Station. Qf deposits generally consist of unconsolidated gravelly, sandy, or silty alluvial deposits with cobbles and boulders on active and recently active alluvial fans.
Qyf	Qyf are young alluvial fan deposits located in the northern and southern segments of the general geology RSA. As described by Yerkes and Campbell (2005), Qyf deposits consist of unconsolidated gravel, sand, and silt, with coarser-grained material closer to the mountains deposited from flooding streams and debris flows.
Tpna	Tpna refer to the Puente Formation (late Miocene to early Pliocene) The Puente Formation consists of marine sandstone, siltstone, and shale deposits with a maximum thickness of 8,500 feet in the Elysian Park Hills area (Lamar 1970). The Puente Formation within the general geology RSA is found near I-5 and SR 110 and consists of very fine to very coarse-grained sandstone.

Sources: California High-Speed Rail Authority, 2017; California Geological Survey, 1997, 1998; Yerkes and Campbell, 2005; Lamar, 1970
Refer to Figure 3.9-3 for correlation with map geologic units.
CGS = California Geological Survey
I = Interstate
RSA = resource study area
SR = State Route

Soils

Soils within the resource hazards RSA have been mapped by the Natural Resources Conservation Service, an agency within the U.S. Department of Agriculture (U.S. Department of Agriculture, Natural Resources Conservation Service 2015). Figure 3.9-4 illustrates generalized soil associations within the resource hazards RSA and represents a recent database compiled by the Natural Resources Conservation Service. Soil types presented on the figure are summarized in Table 3.9-6, which also indicates each type’s susceptibility to corrosion, erosion, or expansive behavior.

Depending on type, some soils are susceptible to erosion and/or expansion, while others are more suitable for construction. Soil-type mapping, emphasizing a soil’s agricultural and engineering properties, is conducted on a countywide (or geographic) basis.

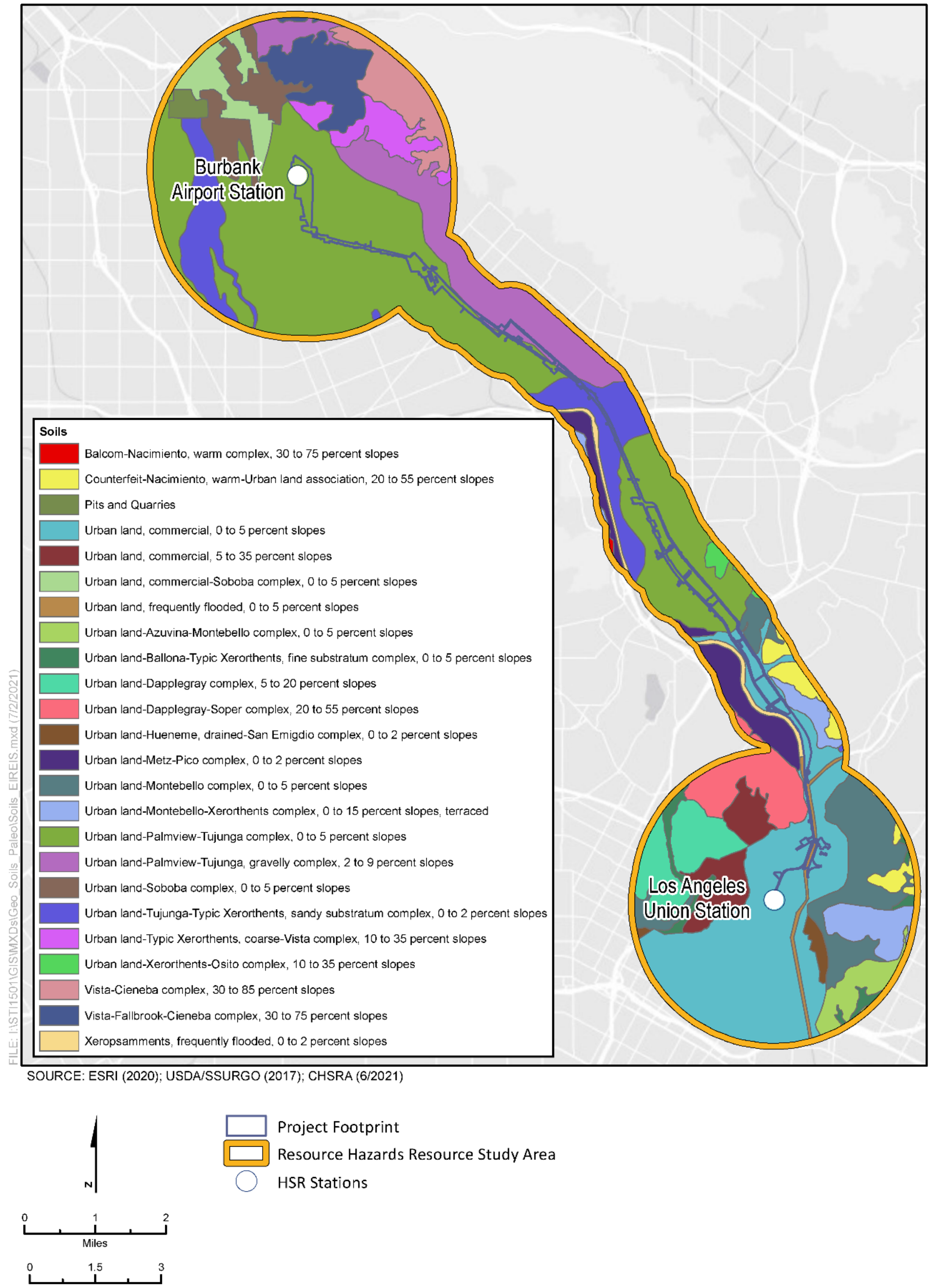


Figure 3.9-4 Soil Associations in the Resource Hazards Resource Study Area

Table 3.9-6 Properties of Major Soil Types in the Resource Study Area

Soil Association Description		Risk of Corrosion-Uncoated Steel	Risk of Corrosion-Concrete	Erosion Potential	Expansion Potential
Urban land-Metz-Pico complex	Urban land	---	---	---	---
	Metz	High	Low	Low - High	Low - High
	Pico	Low	Low	Low - High	Low - Moderate
Urban land-Palmview-Tujunga complex	Urban land	---	---	---	---
	Palmview	Low	Low	Moderate	Moderate
	Tujunga	Low	Moderate	Low	Low - Moderate
Urban land-Palmview-Tujunga, gravelly complex	Urban land	---	---	---	---
	Palmview	Low	Low	Low - Moderate	Moderate
	Tujunga, gravelly	Low	Low	Low	Low
Urban land-Tujunga-Typic Xerorthents, sandy substratum complex	Urban land	---	---	---	---
	Tujunga	Low	Low	Low - Moderate	Low - High
	Typic Xerorthents, sandy substratum	Low	Low	Low - Moderate	Low - Moderate
Vista-Fallbrook-Cieneba complex	Vista	Low	Low	Low - Moderate	Low - Moderate
	Fallbrook	Moderate	Moderate	Low - Moderate	High
	Cieneba	Low	Low	Moderate	Moderate
Urban land-Xerorthents-Osito complex	Urban land	---	---	---	---
	Xerorthents, shallow	Low	Low	Moderate	Low - Moderate
	Osito	Low	Moderate	Low - Moderate	Moderate
Urban land, commercial	Urban land, commercial	---	---	---	---
Urban land, commercial	Urban land, commercial	---	---	---	---
Urban land-Montebello-Xerorthents complex	Urban land	---	---	---	---
	Montebello	Moderate	Low	Moderate	High
	Xerorthents, coarse fill	Moderate	Low	Low - Moderate	Moderate - High
Urban land-Montebello complex	Urban land	---	---	---	---
	Montebello	Moderate	Moderate	Moderate	High
Counterfeit-Nacimiento, warm-Urban land association	Counterfeit	Moderate	Low	Moderate	High
	Nacimiento, warm	Moderate	Low	Moderate	High
	Urban land	---	---	---	---
Urban land-Dapplegray-Soper complex	Urban land	---	---	---	---
	Dapplegray	Moderate	Low	Moderate	High
	Soper	Moderate	Low	Moderate	High

Soil Association Description		Risk of Corrosion-Uncoated Steel	Risk of Corrosion-Concrete	Erosion Potential	Expansion Potential
Urban land, frequently flooded	Urban land, frequently flooded	Low	Low	---	---
Xeropsamments, frequently flooded	Xeropsamments	High	Low	Low	Low

Source: U.S. Department of Agriculture, 2017

Poor Soil Conditions

Generally, soils can be classified as competent (capable of resisting maximum-considered earthquake-level forces while experiencing small deformations), poor (traditionally characterized as having a standard penetration of N[5]<10 [e.g., structures placed within poor soils require project-specific design criteria that address soil structure-related phenomena]), or marginal (the range of soils that cannot readily be classified as either competent or poor). Soil conditions that may have a negative effect on engineered facilities include expansive potential, corrosion potential, collapsible properties, and erosion potential. 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 type 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 (e.g., sands and gravels) are generally non-expansive. Localized areas underlain by expansive soils are likely to occur within the resource hazards RSA given the regional geologic circumstances. A comprehensive geotechnical/geological investigation program, conducted during final design, would determine the locations of expansive soils as well as their deformation potential. The comprehensive geotechnical/geological investigation program is an industry standard required by reviewing agencies. The expansion potential of soil types within the resource hazards RSA is indicated in Table 3.9-6.

Corrosive Soils
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 such as 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. Generally, sands and silty sands do not present a corrosive environment. Clay soils, including those that contain interstitial salt water, can be highly corrosive. Soil types within the resource hazards RSA with the potential to cause corrosion to infrastructure are indicated in Table 3.9-6.

Based on the mapped soil types within the RSA, the majority of soils have low to moderate potential to corrode steel or concrete and a few soil types with high corrosion potential. A comprehensive geotechnical/geological investigation program, conducted during final design, would determine the locations of corrosive soils within the RSA.

Collapsible Soils
Collapsible soils are soil layers that collapse (settle) when water is added under loads (also known as hydroconsolidation). Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials with high apparent strength when they are dry. However, not all of these soil types (aeolian, alluvial or colluvial) are collapsible. Artificial fills that are loose and unconsolidated may also be subject to collapse. When these soils are saturated from

[5] N = The uncorrected blow count from the Standard Test Method for Penetration Test and Split-Barrel Sampling of Soil.

irrigation water or a rise in the groundwater table, pores and voids between the soil particles are removed and the soils collapse.

The dry strength of these materials may be attributed to the clay and silt constituents in the soil and the presence of cementing agents (i.e., salts). Capillary tension may tend to act to bond soil grains. Once these soils are subjected to excessive moisture and foundation loads, the constituency (including soluble salts or bonding agents) is weakened or dissolved, capillary tensions are reduced, and collapse occurs, resulting in settlement. Typical soils are light colored, are low in plasticity, and have relatively low densities. No soil settlement data are available at this time to determine whether or not collapsible soils exist within the resource hazards RSA. However, based on available data from other projects in the vicinity of the HSR Build Alternative, it is inferred that soils with collapse potential may exist in isolated areas of the resource hazards RSA. These areas would be identified in a comprehensive geotechnical/geological investigation program to be conducted prior to project construction as required by GEO-IAMF#1.

Erodible Soils

Erosion includes 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.

Certain soil types demonstrate a higher potential for erosion by rainfall and runoff than other soil types. Soil erodibility depends on many factors, including grain size, organic matter content, structure, permeability, and percentage of rock fragments. This is expressed in the Revised Universal Soil Loss Equation by a factor designated as “K,” the soil erodibility factor. K is defined as a function of texture, organic matter content and cover, structure size class, and subsoil-saturated hydraulic conductivity. Fine-textured soils, which are high in clay, express low erodibility (K values between 0.02 and 0.2) because the strong adherence between individual particles reduces their ability to detach. Coarse-textured soils also have low erodibility because their ability to rapidly infiltrate water reduces surface runoff rates. Medium-textured soils, which are high in silt, have the greatest potential for erosion. The potential for erosion of the soils within the resource hazards RSA is summarized in Table 3.9-6. Per Table 3.9-6, Metz and Pico soil associations, which are generally mapped in the central to southern portions of the resource hazards RSA near the Los Angeles River, are presumed to have high erosion potential.

Soils on steep slopes are often erodible, especially during heavy rain events. Within the resource hazards RSA, the following areas, which are mapped by CGS as landslide hazard zones, may be susceptible to erosion:

- A small area at the south end near the Interstate (I-) 5/State Route (SR) 110 Interchange (near Elysian park)
- A portion in the central area aligning with Griffith Park
- An area near the northeast portion of Hollywood Burbank Airport

Scour, or concentrated stream erosion, is a naturally occurring geomorphic process that can be initiated or accelerated by altering the flow of a stream. Introduction of structures to a stream channel can change the cross-sectional area and/or current patterns, and potentially initiate scour. Scour analysis is required to determine the necessary depth of bridge abutments and piers based on the procedures and guidelines presented in the Federal Highway Administration’s *Evaluating Scour at Bridges, HEC-18* (Federal Highway Administration 1990). Within the resource hazards RSA, the alluvial soils near the Los Angeles River and Verdugo Wash are considered potentially subject to scour.

Areas of Difficult Excavation

Areas of difficult excavation are defined as those requiring more than standard earth-moving equipment or requiring special controls that enable excavation to proceed. Difficult excavation is most likely to occur in bedrock formations and possibly cemented or hardpan strata not amenable to excavation with a ripper-equipped dozer. The use of rippers and roadheaders would take place in weaker-strength rock or highly weathered and/or jointed rock masses. The depth to bedrock within the resource hazards RSA ranges from outcrops near Elysian Park to hundreds of feet deep at the ends of the resource hazards RSA. A comprehensive geotechnical/geological investigation program to identify the locations and depths of the bedrock formations would be performed during the final design phase to identify areas of difficult excavation.

Geologic Hazards

Two broad categories of geologic hazards exist: non-seismic and seismic. Seismic hazards are further divided into primary and secondary seismic hazards. The following sections address the types of non-seismic, primary seismic, and secondary seismic hazards that could be considerations for the Burbank to Los Angeles Project Section.

Non-seismic Hazards

There are two main types of non-seismic hazards that could be considerations for the Burbank to Los Angeles Project Section: landslide hazards and ground subsidence. Although the majority of the resource hazards RSA occurs within well-developed urban areas, there are steep slopes (varying from vertical to a horizontal-to-vertical ratio of 1.5:1) within some portions of the resource hazards RSA and rockfalls due to steep slopes are possible within those portions. In order to identify the areas of steep slopes and evaluate the potential for rockfalls to occur within the resource hazards RSA, a comprehensive geotechnical/geological investigation program must be performed.

Landslide Hazards

Landslides may occur in areas of generally moderate-to-steep topography (e.g., commonly, slopes greater than a horizontal to vertical ratio of 3:1) 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 any combination of these factors.

Within the resource hazards RSA, a small area at the south end near the I-5/SR 110 interchange (near Elysian Park), a portion in the central area aligning with Griffith Park, and a portion at the north end northeast of Hollywood Burbank Airport have been identified by CGS as being prone to landslides, including potential rockfalls. For additional information regarding landslide hazards, please refer to the *Burbank to Los Angeles Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2021a).

Ground Subsidence

Land subsidence is a form of ground settlement that usually results from change 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.

A second type of land subsidence is from a regional withdrawal of groundwater, petroleum, or geothermal resources from sedimentary source rocks can cause the permanent 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.

Groundwater levels are shallow throughout the City of Burbank within the resource hazards RSA adjacent to the Los Angeles River, becoming deeper as the resource hazards RSA travels farther away from the Los Angeles River in the city of Glendale. Groundwater levels become shallow again as the resource hazards RSA nears the Los Angeles River in the city of Los Angeles. Based on the review of the Caltrans Logs of Test Borings and CGS data, groundwater at the southern segment of the resource hazards RSA was detected in previous borings (not conducted for this project section) at a depth of approximately 25 feet below ground surface where the elevation was approximately 635 feet mean sea level. Borings in the city of Burbank south of Alameda Avenue, where the elevation was approximately 680 feet mean sea level, did not encounter groundwater. These reports were completed over previous decades and groundwater elevations can change in conjunction with annual precipitation and groundwater pumping. Historically, groundwater has been as shallow as 20 feet below ground surface at the southern end of the resource hazards RSA near the Los Angeles River (CGS 1997). The historically high groundwater levels specified by the CGS are shown on Figure 3.9-5. Historically high groundwater data was obtained by the CGS from technical publications, geotechnical boreholes, and water well logs dating back to the early 1900s (CGS 1998c).

Primary Seismic Hazards

Primary seismic hazards are those hazards directly associated with earthquakes and include ground surface fault rupture and strong ground shaking. The HSR Build Alternative is within a seismically active area that has a documented history of significant and recurring seismic activity and may be subject to moderate to severe ground shaking. Faults were studied within the resource hazards RSA and the seismicity RSA. Faults crossing near the HSR Build Alternative are detailed in the sections below and categorized by activity level. In addition, significant seismic events that occurred within 200 miles of the HSR Build Alternative were studied.

Surface Fault Rupture

Surface fault rupture refers to the extension of a fault from depth to the ground surface along which the ground breaks, resulting in displacement (e.g., vertical or horizontal offset). Surface fault ruptures are the result of stress relief during an earthquake event and often cause damage to structures within the rupture zone.

Plate tectonics and the forces that affect the earth's crust affect all of Southern California geology and seismicity. Faults are formed at the plate boundaries and other stress points within tectonic plates. Regional faults of concern are:

- Strike-slip faults (e.g., San Andreas, San Jacinto, Elsinore, Newport-Inglewood), which are vertical fractures where the blocks have mostly moved horizontally.
- Normal, reverse, and thrust faults (e.g., Santa Monica, Hollywood, Sierra Madre, San Fernando, Palos Verdes, Raymond, and Verdugo), which are inclined fractures where the blocks have mostly shifted vertically. If the rock mass above an inclined fault moves down, the fault is termed “normal,” whereas if the rock above the fault moves up, the fault is termed “reverse.” A thrust fault is a reverse fault with a dip of 45 degrees or less.
- Blind (buried) thrust faults (e.g., Puente Hills, Northridge, and Elysian Park), which do not rupture all the way up to the surface, so there is no evidence of them on the ground.

California’s Alquist-Priolo Earthquake Fault Zoning Act (AP Act) (CGS 1994a) was enacted to identify and reduce the hazard from surface fault rupture by regulating development projects near active faults. The purpose of the AP Act is to prohibit the location of most structures intended for human occupancy across the trace of an active fault. The AP Act requires that projects in defined “Earthquake Fault Zones” conduct geologic investigations that demonstrate that the sites are not threatened by surface displacement from future fault rupture. To be zoned under the AP Act, a fault must be considered active, or both sufficiently active and well-defined (CGS 1997). The CGS defines an active fault as one that has had surface displacement within Holocene time (approximately the last 11,000 years); and a sufficiently active fault as one that has evidence of Holocene surface displacement along one or more of its segments or branches (CGS 1997). The CGS considers a fault to be well defined if its trace is clearly detectable as a physical feature at or just below the ground surface. The City of Los Angeles Safety Element (1996) identifies a Fault Rupture Study Area, which is similar to an Alquist-Priolo Earthquake Fault Zone except that fault rupture potential is less well known and is less than that required for the Alquist-Priolo Earthquake Fault Zone designation.

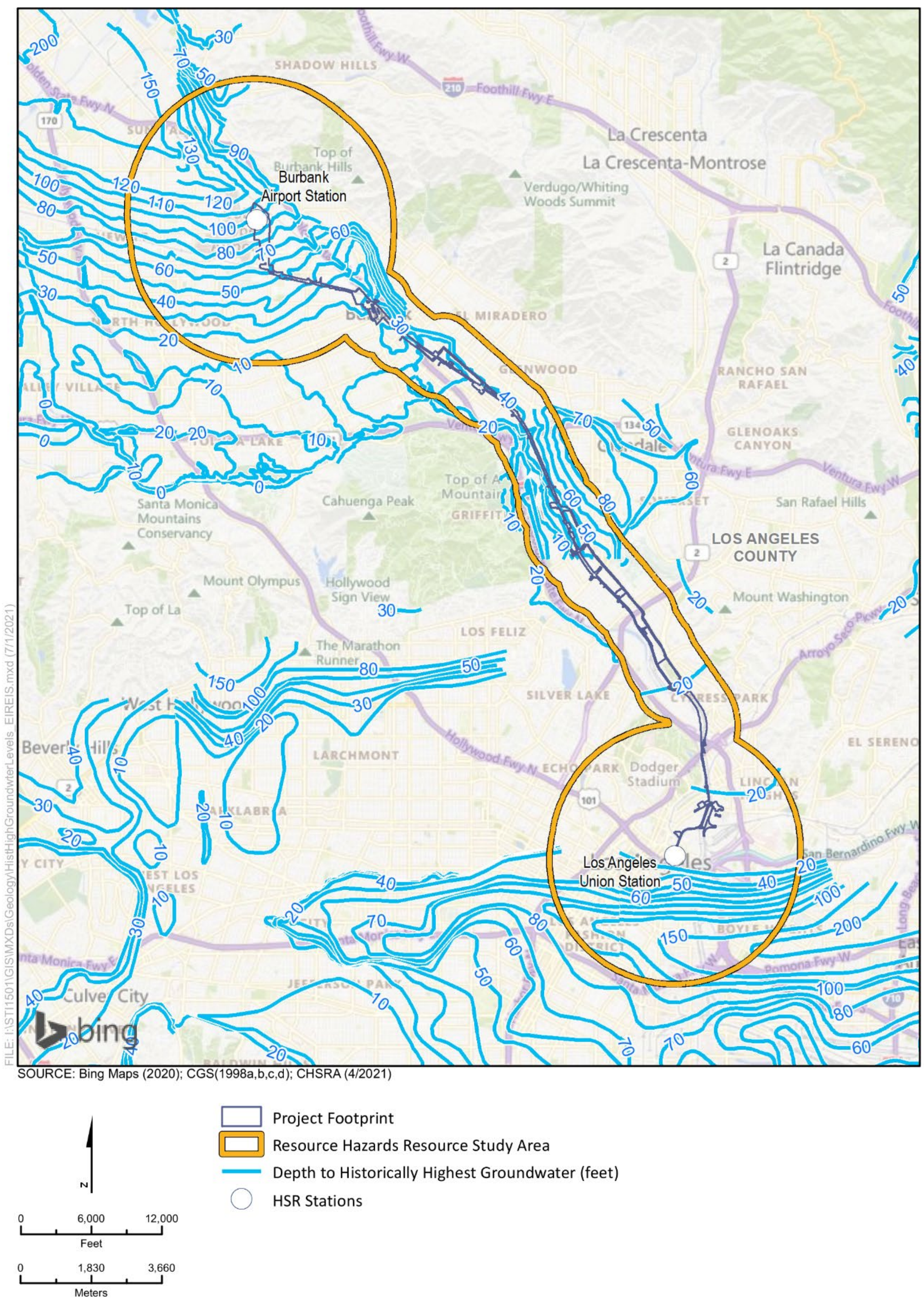


Figure 3.9-5 Historically High Groundwater Levels Map

To reduce confusion concerning fault activity and avoid duplication of the terms “active” and “potentially active” (which are codified in the text of the AP Act), this document follows the nomenclature proposed by Technical Memorandums 2.9.3 and 2.10.6 (Authority and FRA 2010 and 2011). These documents define fault activity levels as follows:

- Hazardous Faults—Faults that, as documented in peer-reviewed reports, have slip rates greater than or equal to 1 millimeter per year and/or a less than or equal to 1,000-year recurrence interval. This type of fault is designated as “active” under the AP Act.
- Potentially Hazardous Faults—Faults that have known or documented Holocene activity or known Quaternary faults with suspected Holocene activity. This type of fault is designated as “potentially active” under the AP Act.

According to these definitions, there are hazardous and potentially hazardous faults in the resource hazards and seismicity RSAs. Hazardous and potentially hazardous faults near or crossing the HSR Build Alternative include the Verdugo Fault, the Hollywood Fault, the Raymond Fault, the Elysian Park (Upper) Fault, and Unnamed fault L66a (Table 3.9-7). These faults are described in more detail below, and their locations relative to the HSR Build Alternative are shown in Figure 3.9-6.

Table 3.9-7 Hazardous and Potentially Hazardous Faults Near or Crossing the High-Speed Rail Build Alternative

Fault Name	Fault Type	Slip Rate (mm/yr)[1]	Probable Maximum Earthquake Magnitude	Distance and Bearing to HSR Build Alternative
Verdugo	Reverse	0.5	6.9	Located 0.3 miles northeast of the Burbank Airport Station and 1.5 miles northeast parallel to the alignment near the proposed locations of three grade separations (Sonora Avenue, Grandview Avenue, and Flower Street).
Hollywood	Strike-Slip	1.0	6.7	Crosses the HSR Build Alternative just north of SR 2
Raymond	Strike-Slip	2.0	6.8	Crosses the HSR Build Alternative just north of SR 2
Elysian Park (Upper)	Reverse	1.9	6.7	Crosses the HSR Build Alternative just north of LAUS
Unnamed fault L66a	Unspecified	NA	Unspecified	Located 1.5 miles southwest of the intersection of N Hollywood Way and Vanowen Street

Sources: U.S. Geological Survey and supporting agency California Geological Survey, 2006; Southern California Earthquake Data Center, 2016
HSR = high-speed rail
mm/yr = millimeters per year
LAUS = Los Angeles Union Station
SR = State Route
1 = Values obtained from USGS online website on U.S. Quaternary Fault and Fold Database page
NA = Not available

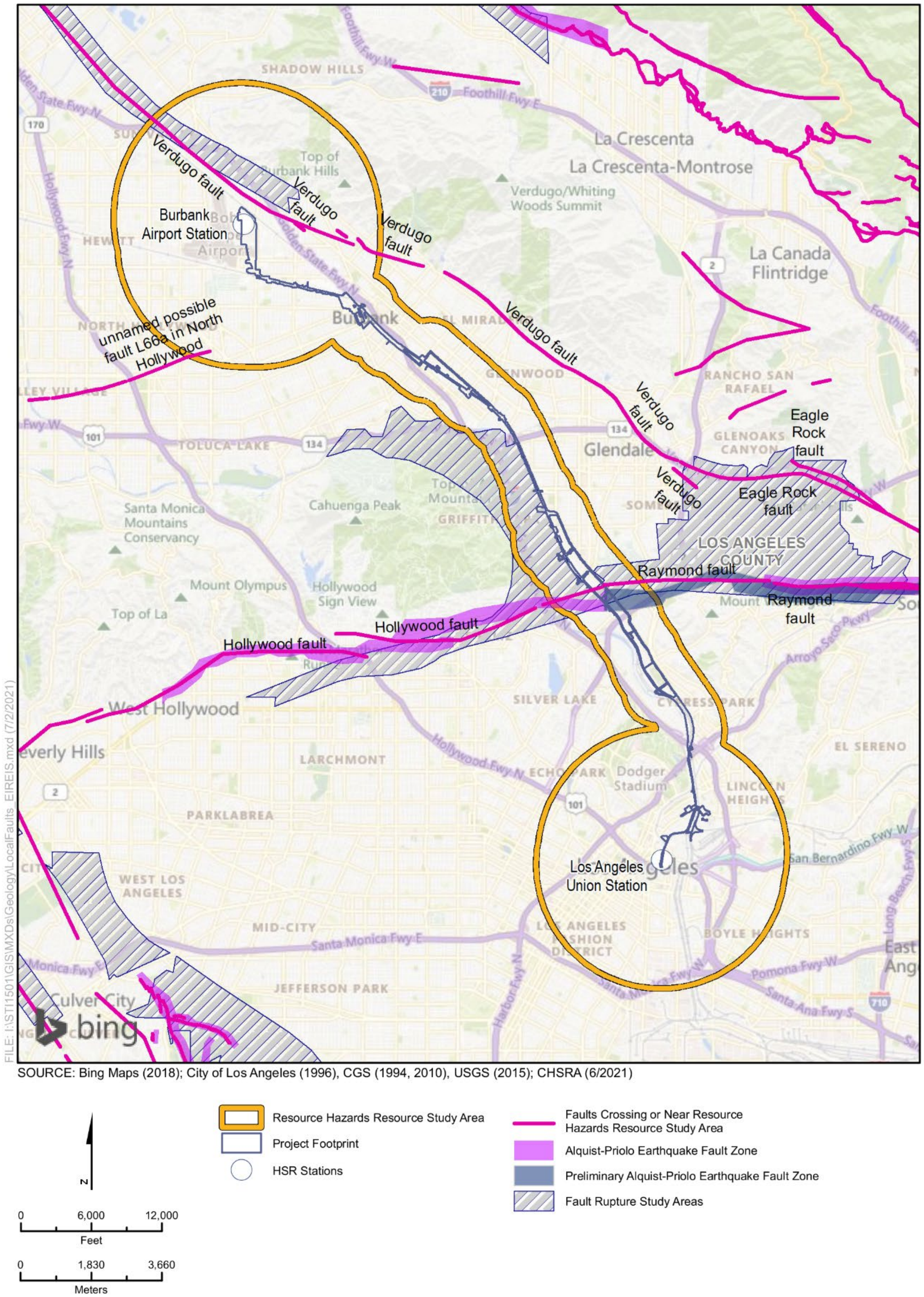


Figure 3.9-6 Hazardous and Potentially Hazardous Faults in the Resource Hazards Resource Study Area

According to the General Plans for the cities of Burbank and Glendale, the Verdugo, Hollywood, and Raymond faults have the potential to cause surface fault rupture within the resource hazards RSA. The Verdugo fault is approximately 1.5 miles northeast of the HSR Build Alternative near the proposed locations of grade separations (Sonora Avenue, Grandview Avenue, and Flower Street). The faults discussed in this section are considered in the City of Los Angeles Safety Element (1996). A portion of the resource hazards RSA approximately from SR 134 to south to Tyburn Street in the city of Los Angeles falls within a Fault Rupture Study Area.

Verdugo Fault

The northwest-southeast trending Verdugo fault is the major bounding structure of the eastern San Fernando Valley and is considered active, although not within an Alquist-Priolo Earthquake Fault Zone. Weber et al. (1980) reported possible fault scarps 6 to 10 feet high in Qyf/Qf-age deposits in the Burbank area. This fault is inferred to be potentially hazardous based on available data and the definition above.

The General Plans for the cities of Burbank and Glendale address the potential for seismic activity of the Verdugo fault in more detail from a planning perspective. The City of Glendale (2003), in its 2003 Safety Element, states "most investigators agree that the Verdugo fault is active and therefore has the potential to generate future surface-rupturing earthquakes," and "geological studies should be conducted for sites within the Verdugo fault hazard management zone if new development or significant redevelopment is proposed." The City of Burbank (1997) indicates that "the fault should be considered active for planning and development purposes, until geologic studies can resolve the issue," and the "proximity of the Verdugo fault to the [C]ity of Burbank makes the earthquake scenario on this fault particularly useful for long-range urban planning and worst-case disaster response planning, even though the actual likelihood of an earthquake on this fault is low."

Hollywood Fault

The CGS (2010) shows the Hollywood fault projecting from approximately 1.25 miles west of the City of Los Angeles and City of Glendale boundary near Tyburn Street. The Southern California Earthquake Data Center (2016), states that a rupture of the entire fault zone could produce an earthquake of a magnitude ranging from 6 to 7. The dip of the fault (angle of inclination from horizontal) is estimated to be about 70 degrees dipping North (Southern California Earthquake Data Center, 2016). The City of Glendale General Plan also recognizes the fault zone. Hollywood Fault is strike slip fault of about 17 kilometers in length. The Hollywood fault is a strike-slip fault about 17 kilometers in length and, based on the definition above, is considered to be hazardous.

Raymond Fault

The CGS (2010) shows the Raymond fault transecting the HSR Build Alternative near Tyburn Street at the boundary between the City of Los Angeles and the City of Glendale. The Southern California Earthquake Data Center (2016), states that a rupture of the entire fault zone could produce an earthquake of a magnitude ranging from 6 to 7. The dip of the fault (angle of inclination from horizontal) is estimated to be about 79 degrees dipping north (Southern California Earthquake Data Center, 2016). The City of Glendale General Plan also recognizes the fault zone. The Raymond fault is a strike slip fault of about 22 kilometers in length and is considered hazardous.

Elysian Park (Upper)

The CGS (2010) shows the Elysian Park (Upper) fault parallel to the HSR Build Alternative and crossing Raymond fault. The National Seismic Hazard Maps – Source parameters models the earthquake magnitude range from 6.5 to 6.7 with a slip rate of 1.3 mm/yr. The dip of the fault is estimated to be 50 degrees, dipping direction to the northeast. Elysian Park (Upper) is a reverse fault of about 20 kilometers in length and is considered hazardous.

Unnamed Fault L66a

The CGS (2010) shows the unnamed fault L66a projecting from approximately 1.5 miles southwesterly from Burbank Airport Station and the HSR Build Alternative. The fullest description of this fault (identified as unnamed fault L66a by Weber, et.al. [1980]) indicates it is defined on the 1901 USGS and 1928 USGS topographic maps as an elevation change across a possible low, south-facing break in slope in younger Holocene alluvial deposits. This feature may be associated with subsidence north of the Benedict Canyon fault. Given the south-facing break in slope and the subsidence observed north of the Benedict Canyon Fault, L66a is inferred to be an east-trending fault, if in fact it is a fault. The unnamed fault L66a lies outside any City of Los Angeles Fault Rupture Study Area. For the purpose of this study, this fault is considered to be potentially hazardous.

Other Faults

Within the Seismicity RSA (i.e., within 30 miles of the HSR Build Alternative), there are many more hazardous and potentially hazardous faults. All of these faults are shown on Figure 3.9-7. Table 3.9-8 lists the hazardous faults, and Table 3.9-9 lists the potentially hazardous faults.

Historic Seismicity

Southern California is one of the most seismically active regions in the U.S. Table 3.9-10 summarizes the major seismic events in order of magnitude. The largest-magnitude earthquake recorded was a magnitude 7.9 along the San Andreas Fault at Fort Tejon on January 9, 1857. The most damaging earthquakes in the Los Angeles Basin have been the San Fernando event on February 9, 1971 (magnitude 6.4) and the Northridge event on January 17, 1994 (magnitude 6.7).

Seismic Ground Motion

Ground shaking occurs in response to energy released during an earthquake or fault rupture. The energy travels through subsurface rock, sediment, and soil materials, resulting in motion experienced at the ground surface. Ground shaking intensity varies with the magnitude of the earthquake, the distance from the source of energy release, fault length, style of faulting, dip angle, slip rate, and the type of rock or sediment through which the seismic waves travel. Depending on the level of ground motion and the stiffness of the soil, the ground motions can amplify or de-amplify. For example, ground motion is greatly amplified in areas underlain by deep deposits of loose, unconsolidated soils.

Table 3.9-8 and Table 3.9-9 present lists of the hazardous and potentially hazardous faults within the seismicity RSA, along with the approximate closest distance from the HSR Build Alterative to these faults. Figure 3.9-7 illustrates the locations of these faults within the seismicity RSA. Moderate to large earthquakes occurring along any of these major hazardous and potentially hazardous faults in the region would result in strong seismic shaking along the HSR Build Alternative.

The intensity of the ground shaking is estimated in terms of geometric mean peak ground acceleration. American Society of Civil Engineers Standard ASCE/SEI 7-10 presents peak ground acceleration on maps derived from ground motion data calculated on a grid of sites across the U.S. The peak ground acceleration is estimated for the maximum considered earthquake, defined as an earthquake with a probability of exceedance of 2 percent in 50 years (a return period of 2,475 years), which is adopted by the Authority (2010) as the upper limit of ground motion for seismic design consideration. The contours of peak ground acceleration expressed as a percentage of the acceleration of gravity (g), are presented on Figure 3.9-8. The entire HSR Build Alternative is included in Seismic Zone 4 (1 in 10 chance that an earthquake with an active peak acceleration level of 0.40g [4/10 the acceleration of gravity] would occur in the next 50 years) by the most recent California Uniform Building Code (2016).These figures and the peak ground acceleration rates are provided to describe the affected environment and do not reflect the final seismic design criteria specified by the Authority.

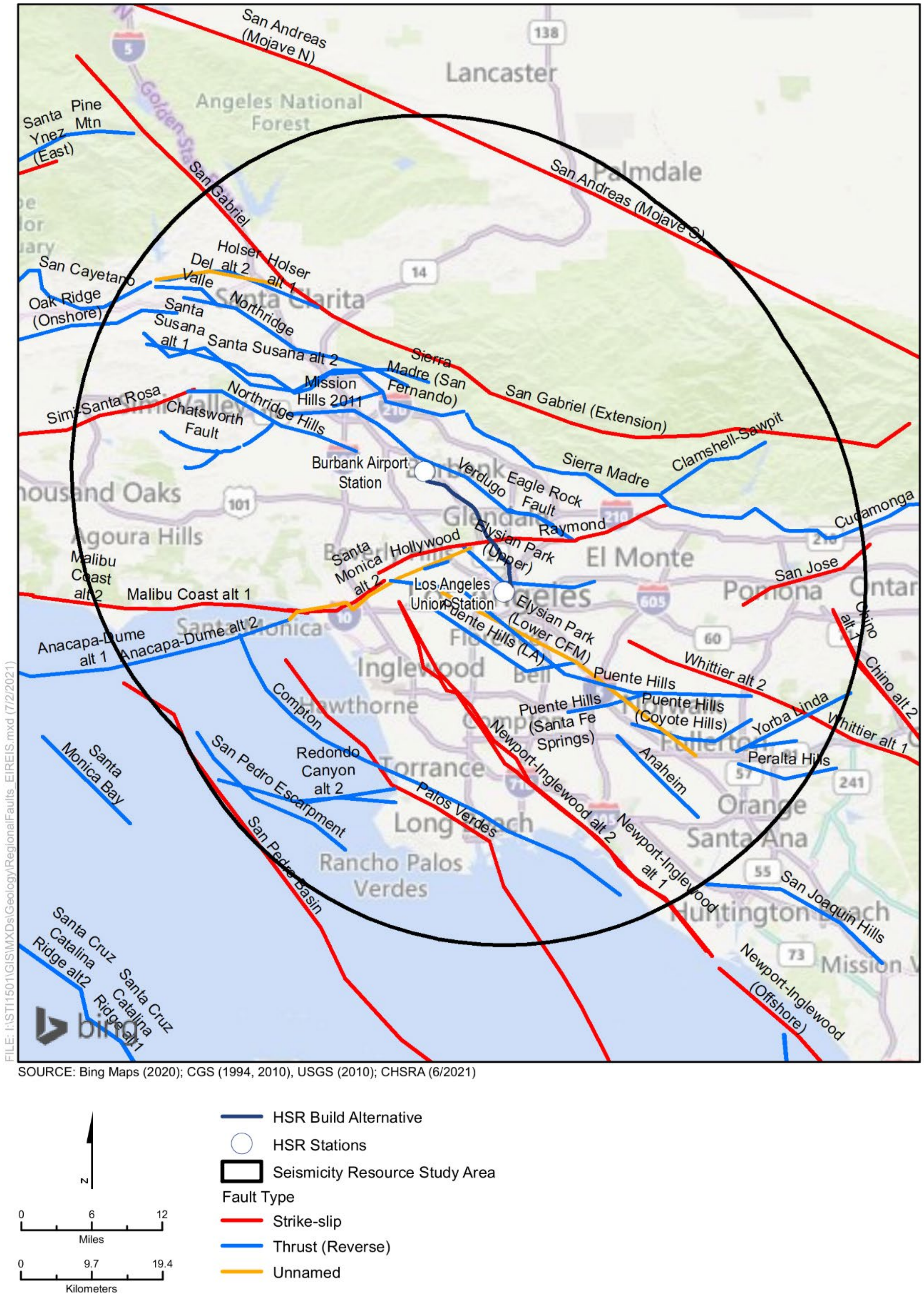


Figure 3.9-7 Hazardous and Potentially Hazardous Faults in the Seismicity Resource Study Area

Table 3.9-8 Hazardous Faults in the Seismicity Resource Study Area

Fault	Approximate Distance from HSR Build Alternative (miles)	Type of Fault	Recurrence Interval (years)[1]	Slip rate (mm/yr)[1]	Maximum Earthquake Magnitude
Hollywood Fault	0	Strike-slip	6,000 to 11,000	1	6.7
Raymond Fault	0	Strike-slip	3,000 to 5,000	2	6.8
Elysian Park (Upper)	0	Reverse	NA	1.9	6.7
Elysian Park Thrust (Lower CFM)	2.3	Thrust	340 to 540	1.7	Unspecified
Santa Monica Fault alt 2	4.8	Strike-Slip	7000 to 8000	2.4	7.4
Sierra Madre Fault	500 to 7,500	Reverse	625	3	7.3
Northridge Thrust	6.9	Thrust	NA	1.5	6.9
Sierra Madre Fault (San Fernando)	7.6	Reverse	200 to 2,000	2	7.3
San Gabriel Fault Zone	8.5	Strike-Slip	NA	1	7.3
Newport-Inglewood Fault Zone	8.5	Strike-Slip	1,200 to 3,000	1.3	7.3
Santa Monica alt 2	9.8	Strike-Slip	7,000 to 8,000	2.4	7.3
Whittier Fault alt 1	10.5	Strike-Slip	1,800 to 3,050	1 to 5	NA
Clamshell-Sawpit	14.3	Reverse	2900	0.5	6.7
Sierra Madre, Santa Susana Section	14.3	Reverse	NA	5	6.9
Simi-Santa Rosa Fault Zone	15.0	Strike-Slip	1,000	1	6.9
Compton Thrust	17.8	Thrust	700 to 13,700	0.2 to 1	Unspecified
Palos Verdes Fault Zone	17.6	Strike-Slip	NA	3	7.7
San Cayetaro Fault	19.2	Thrust	NA	6	7.2
Redondo Canyon Fault alt 2	22	Reverse	NA	0.2 to 1	Unspecified
Oak Ridge Fault	25.5	Reverse	NA	3.6	7.4
Anacapa-Dume Fault alt 2	26.3	Thrust	NA	3	7.2
Chino Fault alt 1	28.2	Strike-slip	9,500 to 11,600	0.06	NA
San Andreas Fault Zone	29.7	Strike-slip	100 to 135	29	7.56

Source: U.S. Geological Survey National Seismic Hazard Maps, 2008
Distances measured from the nearest fault trace to the HSR Build Alternative
alt = fault model
CM = Coyote Mountains section of the Elsinore fault
GI = Glen Ivy section of the Elsinore fault
HSR = high-speed rail
J = Julian section of the Elsinore fault
NSB = North San Bernardino section of the South San Andreas fault
SM = South Mojave section of the South San Andreas fault
SSB = South San Bernardino section of the South San Andreas fault
T = Temecula section of the Elsinore fault
W = Whittier section of the Elsinore fault
1 = Values obtained from USGS online website on U.S. Quaternary Fault and Fold Database page

Table 3.9-9 Potentially Hazardous Faults in the Seismicity Resource Study Area

Fault	Approximate Distance from HSR Build Alternative (miles)	Type of Fault	Recurrence Interval (years)[1]	Slip rate (mm/yr)[1]	Maximum Earthquake Magnitude
Verdugo Fault	0.3	Reverse	NA	0.5	6.9
Possible Fault in North Hollywood (Unnamed Fault L66a)	1.5	Unspecified	NA	NA	Unspecified
Eagle Rock Fault	2.5	Thrust	NA	NA	Unspecified
Puente Hills Thrust (Los Angeles)	4.5	Thrust	NA	0.7	7.0
Mission Hills Fault	8.0	Reverse	NA	NA	Unspecified
Puente Hills Thrust (Santa Fe Springs)	11.5	Thrust	NA	0.7	6.7
Chatsworth Fault	14.1	Unspecified	NA	NA	6.8
Anaheim	16.1	NA	NA	NA	NA
Holser Fault	18.6	Reverse	NA	NA	6.8
Del Valle Fault	18.8	Reverse	NA	NA	NA
San Jose Fault	20.0	Strike-slip	NA	0.5	6.7
Malibu Coast Fault	20.2	Strike-slip	NA	0.3	7.0
Yorba Linda Fault	NA	NA	NA	NA	NA
San Pedro Basin Fault	30.0	Unspecified	NA	NA	Unspecified

Source: U.S. Geological Survey National Seismic Hazard Maps, 2008
Distances measured from the nearest fault trace to the HSR Build Alternative
alt = fault model
CM = Coyote Mountains section of the Elsinore fault
GI = Glen Ivy section of the Elsinore fault
HSR = high-speed rail
J = Julian section of the Elsinore fault
NSB = North San Bernardino section of the South San Andreas fault
SM = South Mojave section of the South San Andreas fault
SSB = South San Bernardino section of the South San Andreas fault
T = Temecula section of the Elsinore fault
W = Whittier section of the Elsinore fault
1 = Values obtained from USGS online website on U.S. Quaternary Fault and Fold Database page

Table 3.9-10 Significant Seismic Events in Southern California

Date	Location/Event	Magnitude	Latitude (degree)	Longitude (degree)	Distance to HSR Build Alternative (miles)
January 9, 1857	Fort Tejon	7.9	35.30	-119.80	110.34
July 21, 1952	Kern County	7.7	35.00	-119.02	64.75
June 28, 1992	Landers	7.3	34.20	-116.44	105.13
October 16, 1999	Hector Mine	7.1	34.59	-116.27	117.47
May 19, 1940	Imperial County	6.7	32.73	-115.50	182.55
January 17, 1994	Northridge	6.7	34.21	-118.54	8.85
February 9, 1971	San Fernando	6.4	34.41	-118.40	12.53

Source: U.S. Geological Survey, 2010
HSR = high-speed rail

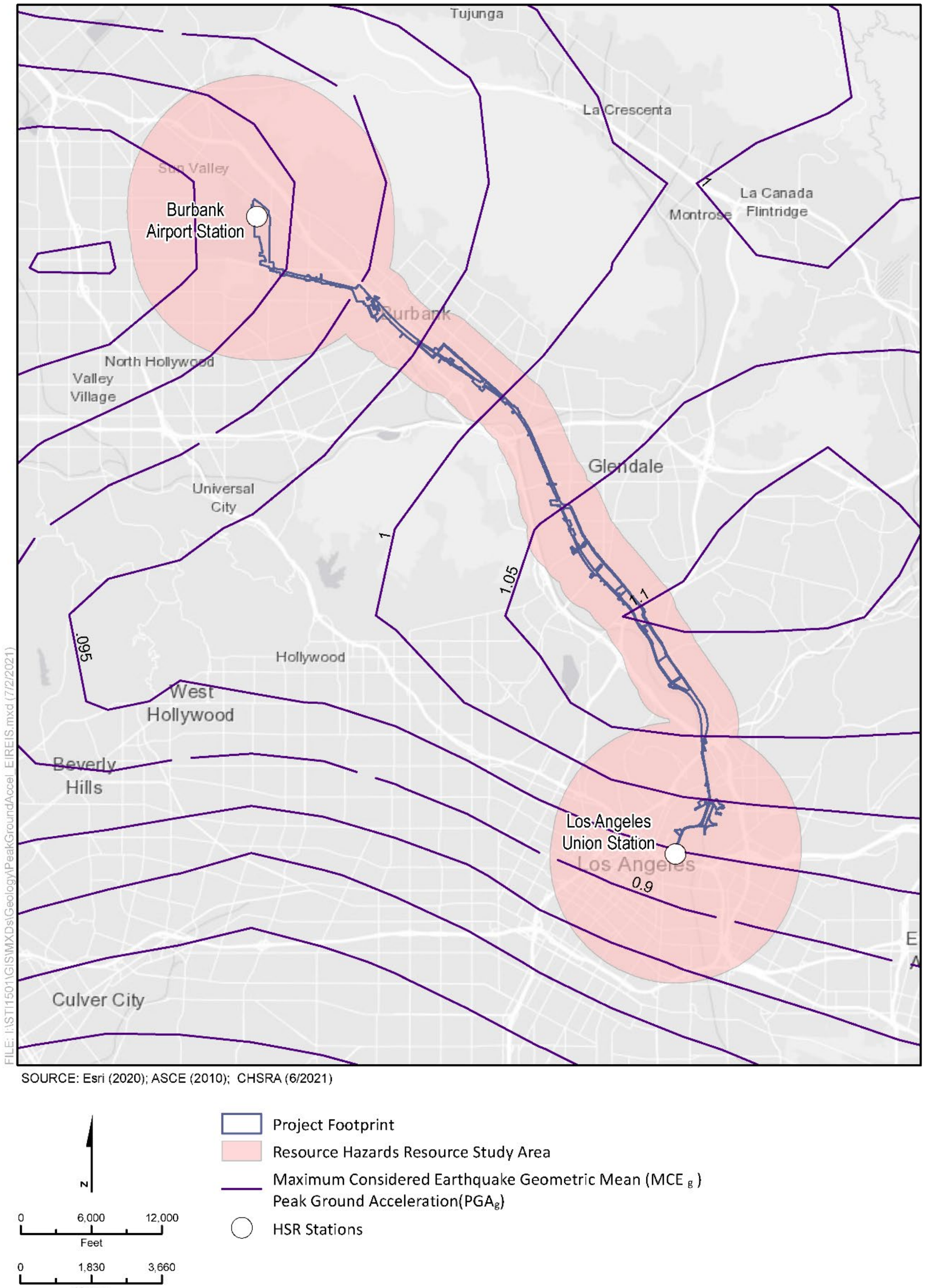


Figure 3.9-8 Peak Ground Acceleration

Figure 3.9-9 Secondary Seismic Hazard Zones

Secondary Seismic Hazards

Secondary seismic hazards include phenomena that occur as a result of ground shaking, such as seismically induced liquefaction, lateral spreading, landslides, floods, dam failure, seiches, and tsunamis.

Liquefaction

Liquefaction occurs when saturated, low relative density, low plastic materials are transformed from a solid to a near-liquid state. This phenomenon occurs when moderate to severe ground shaking causes pore-water pressure to increase. Site susceptibility to liquefaction is a function of the depth, density, soil type, and water content of granular sediments, along with the magnitude and frequency of earthquakes in the surrounding region. Saturated sands, silty sands, and unconsolidated silts within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects.

In the cities of Burbank, Glendale, and Los Angeles, the HSR Build Alternative would be located in areas identified by CGS (CGS 1998a, 1998b, 1998c, and 1998d) to be potentially susceptible to liquefaction. The specific areas are shown on Figure 3.9-9.

Lateral Spreading

Lateral spreading is permanent lateral ground displacement that can occur during liquefaction on gently sloping or level ground where the surficial soils move toward slope faces (e.g., those of bridge abutments, and river and stream banks). The failed soils may exhibit a rapid, fluid-like flow. Lateral spreading potential exists at the same locations identified by CGS as having potential for liquefaction. These locations are shown on Figure 3.9-9.

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. Areas designated by CGS as having potential for landslide are shown on Figure 3.9-9. Within the resource hazards RSA, a small area at the south end near the I-5/SR 110 interchange (near Elysian Park), a portion in the central area aligning with Griffith Park, and a portion at the north end northeast of Hollywood Burbank Airport have been identified by CGS as being prone to landslides, including potential rockfalls. For additional information regarding landslide hazards, please refer to the *Burbank to Los Angeles Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2021a).

Seismically Induced Flood Hazards

Seismically induced flood hazards include flooding caused by failure of water-retaining structures, such as dams, reservoirs, levees, or large storage tanks during a seismic event, as well as seiche and tsunami waves.

Dams near the resource hazards RSA that could potentially fail due to seismic shaking are the Hansen Dam and Eagle Rock Dam, which are at distances of approximately 5 and 4 miles from the HSR Build Alternative, respectively. Reservoirs near the HSR Build Alternative that could fail due to seismic shaking are Reservoir Numbers 1, 4, and 5 in the city of Burbank; the 10th and Western Reservoir in the city of Glendale; and the Diedrich Reservoir, Glenoaks 968 Reservoir, and Elysian Reservoir in the city of Los Angeles. City of Burbank Reservoirs 1, 4, and 5; the 10th and Western Reservoir; the Diedrich Reservoir; and the Elysian Reservoir are within the resource hazards RSA. The Glenoaks 968 Reservoir is approximately 1 mile from the HSR Build Alternative. The HSR Build Alternative is within the inundation areas of the aforementioned dams and reservoirs. Seismically induced dam or reservoir failure is possible; however, dam failures 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.

A seiche refers to the movement of an enclosed body of water, such as a bay, lake, or reservoir, due to periodic oscillation. Seiches commonly occur as a result of intense seismic shaking or catastrophic landslides that displace large amounts of water in a short period of time. The period of oscillation varies and depends on the size of the waterbody. 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 significant damage to nearby structures, including dams, shoreline facilities, and levees or embankments. Although the area immediately surrounding Hansen Dam and Eagle Rock Dam would likely see flooding due to seismic seiche effects, due to the distance to Hansen Dam (5.9 miles northwest), flooding within the resource hazards RSA as a result of seismic seiche is unlikely to occur.

Tsunamis are a series of large wavelength waves in a water body caused by a sudden large displacement of water. They are commonly generated by large magnitude, offshore earthquakes or submarine landslides. The waves are of a very long period, such that there is a retreat of water away from the coastline followed by a subsequent surge of water along low-lying coastal areas. Due to the distance to the ocean (greater than 10 miles), flooding from tsunami is unlikely to occur within the resource hazards RSA.

Geologic Resources

Mineral Resources

This section only refers to geologic materials, such as sand and gravel, within the resource hazards RSA. The CGS classifies land throughout the state into one of three different categories of nonfuel Mineral Resource Zones (MRZ) to show where economically significant mineral resource deposits occur. The three classifications of MRZ include:

- 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

According to the CGS, the resource hazards RSA passes through several areas designated MRZ-2 and MRZ-3 (CGS 1994). The resource hazards RSA south of San Fernando Road is predominantly zoned MRZ-2, whereas north of San Fernando is generally MRZ-3. A designation of MRZ-2 indicates that limited research has identified the presence of significant mineral resources. In contrast, a designation of MRZ-3 indicates that due to insufficient data, the presence and extent of significant mineral resources are unknown. Zones classified MRZ-3 are typically heavily developed and are not likely to be evaluated for mineral resources any further. Information on the mineral resource potential in the resource hazards RSA was obtained from CGS publications (Cole 1988; Koehler 1999; Busch 2009).

This trend is consistent the portions of the resource hazards RSA that traverse the cities of Burbank, Glendale, and Los Angeles.

Five mining facilities are near the HSR Build Alternative. Table 3.9-11 provides additional information on those facilities, including their current status and the resources mined at those facilities.

Table 3.9-11 Mining Facilities near the High-Speed Rail Build Alternative

U.S. Geological Survey Mineral Deposit Identification Number	Site Name	Approximate Distance to HSR Build Alternative (miles)	Operation Type/Status	Resource Mined
10284752	Westlake & Sons	0.5	Past Producer	Sand and gravel
10235923	City of Los Angeles	0.3	Past Producer	Sand and gravel
10236501	Beyrle	0.2	Past Producer	Sand and gravel
10138910	Home Teaming and Transfer Co.	0.15	Past Producer	Sand and gravel
10235902	Davidson Brick Company	0.2	Producer	Clay

Source: U.S. Geological Survey, 2016
HSR = high-speed rail

Fossil Fuel Resources (Methane, Oil, and Natural Gas)

Limited oil and gas exploration and pumping from proven reserves have occurred in the areas surrounding the HSR Build Alternative, and the resource hazards RSA passes through the Los Angeles City Oil Field (DOGGR District 2 Oil Fields Map; DOGGR 2016). According to Wildcat Maps and the DOGGR digital wells database (DOGGR 2016), the wells within the resource hazards RSA and vicinity fall into two categories: (1) idle (not being used for production, injection, or other purposes but have also not been permanently sealed), or (2) plugged and abandoned dry wells (permanently sealed and closed). The locations of these wells are shown on Figure 3.9-10.

Abandoned wells and dry holes can represent potential hazards for nearby buildings and occupants. These holes represent potential vertical migration pathways for crude oil, methane, hydrogen sulfide, and other compounds. The DOGGR regulates drilling and abandonment of wells and dry holes. DOGGR regulations evolved over time to address problems and hazards identified in older wells. As a result, there are fewer problems associated with recently plugged wells and dry holes. Nevertheless, even when a well is plugged in accordance with DOGGR regulations, leaks can occur later.

Hazardous subsurface gases, including methane and hydrogen sulfide, which can occur naturally in soil, rock, or groundwater, may be found within the resource hazards RSA. Also shown on Figure 3.9-10 are areas identified by the City of Los Angeles as Methane Zones and Methane Buffer Zones. The boundaries of the zones were primarily defined by the proximity to oil and natural gas extraction wells. These zones were established by the City of Los Angeles Department of Building and Safety to mitigate risks associated with subsurface methane deposits. As a consequence of idle or abandoned dry wells in the vicinity of LAUS, City of Los Angeles methane zones and methane buffer zones have been identified within the resource hazards RSA.

Geothermal Resources

Geothermal resources were not identified by CGS maps within the resource hazards RSA (DOGGR 2016).

3.9.5.2 Paleontological Resources

As described in Section 3.9.5.2, four geologic units are mapped within the paleontological resources RSA (Yerkes and Campbell 2005). From youngest to oldest, these units include:

- Artificial fill (Holocene)
- Alluvial Fan Deposits (Holocene)
- Young Alluvial Fan Deposits, undivided (Holocene to late Pleistocene)
- Puente Formation, sandstone member (late Miocene)

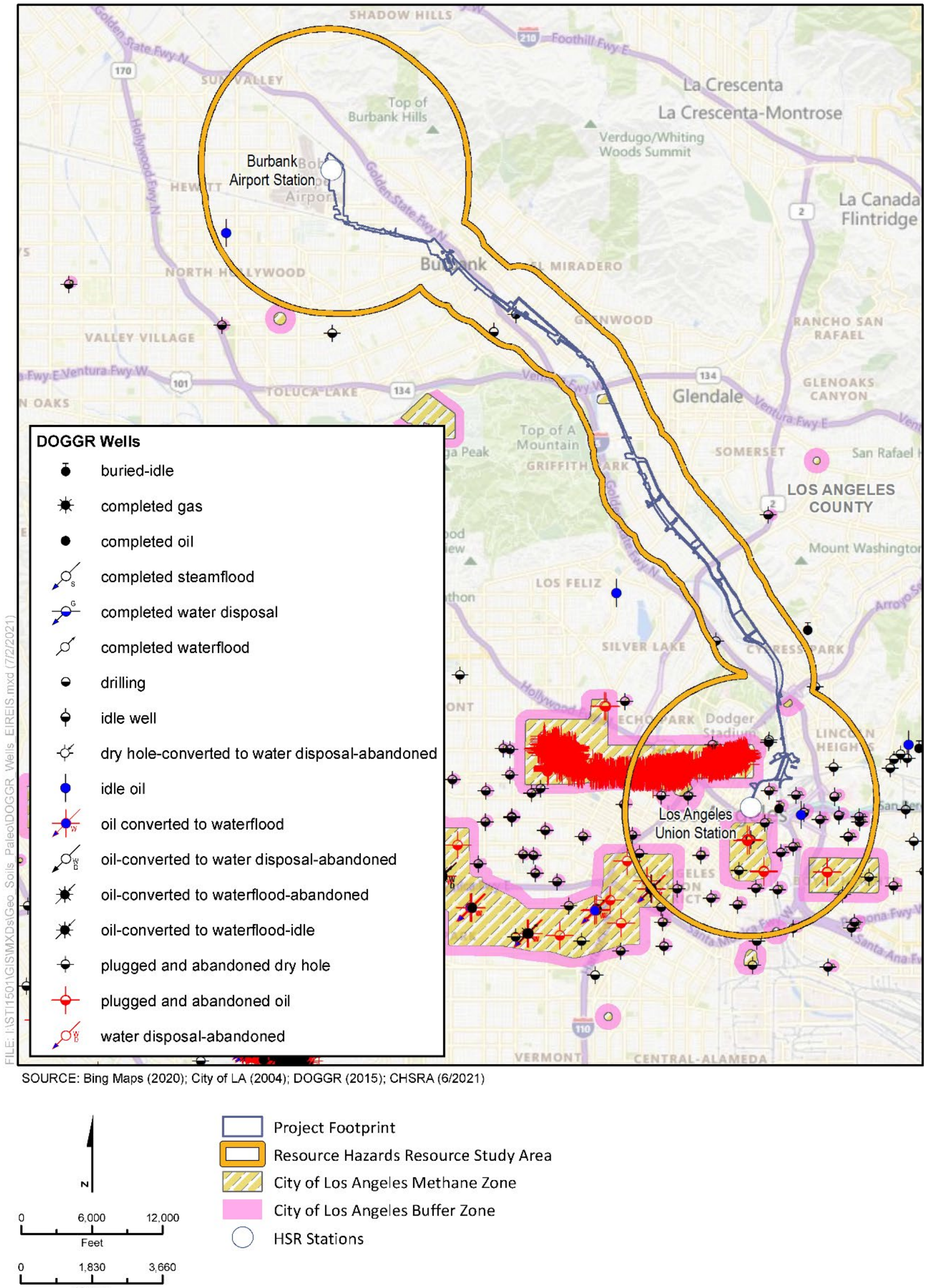


Figure 3.9-10 California Division of Oil, Gas, and Geothermal Resources Wells

As described in Section 3.9.4.4, the paleontological sensitivity of these geologic units was determined using the SVP sensitivity ratings of high, low, no, and undetermined potential for producing scientifically significant fossils based on the results of the literature review and the fossil locality search through the LACM. The paleontological sensitivity of these geologic units is summarized in Table 3.9-12 and described in more detail below. Figure 3.9-11 (Sheets 1 through 3) illustrates the paleontological sensitivity of the geologic units within the paleontological resources RSA. For additional information, refer to the *Burbank to Los Angeles Project Section: Paleontological Resources Technical Report* (Authority 2021b).

Table 3.9-12 Paleontological Sensitivity Evaluation of Geologic Units in the Paleontological Resources Resource Study Area

Geologic Unit	Map Unit Symbol(s)	Age (years ago)	Geologic Epoch	Paleontological Sensitivity[1]
Artificial Fill	Af	Present to 100	Holocene	No
Alluvial Fan Deposits	Qf	Present to 11,700	Holocene	Low: Above a depth of 10 feet High: Below a depth of 10 feet
Young Alluvial Fan Deposits, undivided	Qyf	Present to 129,000	Holocene to late Pleistocene	Low: Above a depth of 10 feet High: Below a depth of 10 feet
Puente Formation, sandstone member	Tpna	5.333 to 11.63 million	Late Miocene	High

Sources: Yerkes and Campbell, 2005; International Commission on Stratigraphy, 2016
[1] Paleontological sensitivity assignment based on SVP guidelines (SVP 2010)
SVP = Society of Vertebrate Paleontology

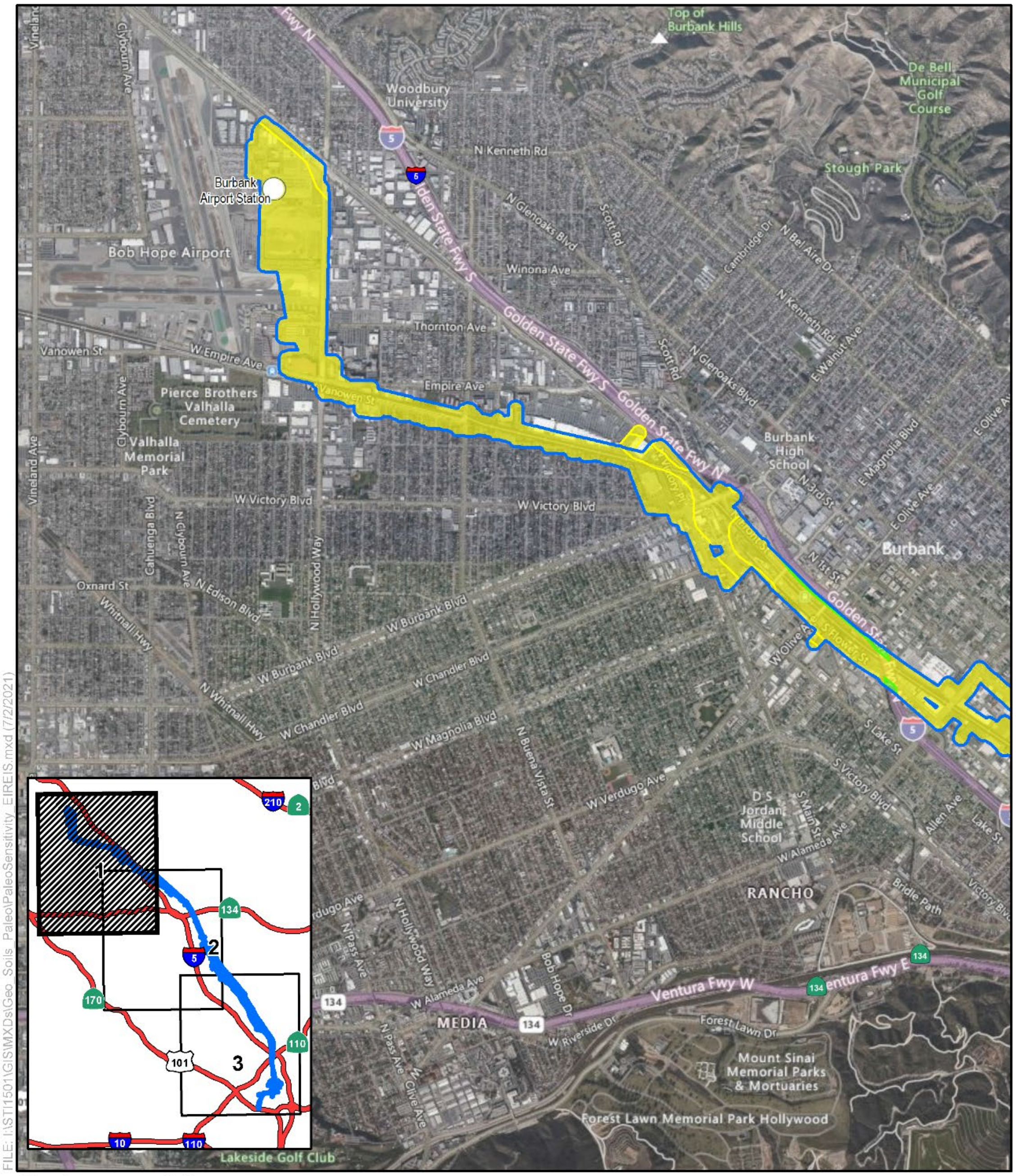
Artificial Fill

Artificial fill is mapped within the paleontological resources RSA along I-5 from approximately W Burbank Boulevard to W Providencia Avenue in the city of Burbank, as well as in a small portion of SR 134 just east of where it crosses San Fernando Road in the city of Glendale (Authority 2021b). However, it likely occurs elsewhere within the paleontological resources RSA along the existing railroad tracks, highways, streets, and bridges where it was used during construction to provide suitable foundation or drainage or to adjust for changes in topography and for overcrossings and interchanges. Artificial fill was noted during the field inspection at several overcrossings within the paleontological resources RSA, including the N San Fernando Boulevard overcrossing at N Hollywood Way in the city of Burbank; the SR 134 and Fairmont Avenue overcrossings at San Fernando Road in the city of Glendale; the San Fernando Road and San Fernando Road W overcrossings at the Colorado Street I-5 on-/off-ramps in the cities of Glendale and Los Angeles; and the SR 2 overcrossings at San Fernando Road, Casitas Avenue, and the existing railroad right-of-way in the city of Los Angeles (Authority 2021b).

While artificial fill may contain fossils, these fossils have been removed from their original location and are thus out of stratigraphic context. Therefore, they are not considered important for scientific study. As such, artificial fill has no paleontological sensitivity.

Alluvial Fan Deposits

Alluvial Fan Deposits are mapped throughout the majority of the paleontological resources RSA, along San Fernando Road from approximately Delia Avenue to N Hollywood Way, around the intersection of Winona Avenue and N San Fernando Boulevard, around the intersection of East Avenue and N San Fernando Boulevard, and from approximately W Burbank Boulevard to W Magnolia Boulevard in the city of Burbank. Alluvial Fan Deposits are also mapped from approximately Grandview Avenue to Broadway/Brazil Street in the cities of Glendale and Los Angeles, as well as from SR 2 to LAUS in the city of Los Angeles (Authority 2021b).



SOURCE: Bing (2020);CHSRA (6/2021)

Paleontological Resources Resource Study Area

HSR Stations

Paleontological Sensitivity

No Sensitivity

Low Sensitivity – Surface to depth 10 ft, High Sensitivity – Below 10 ft

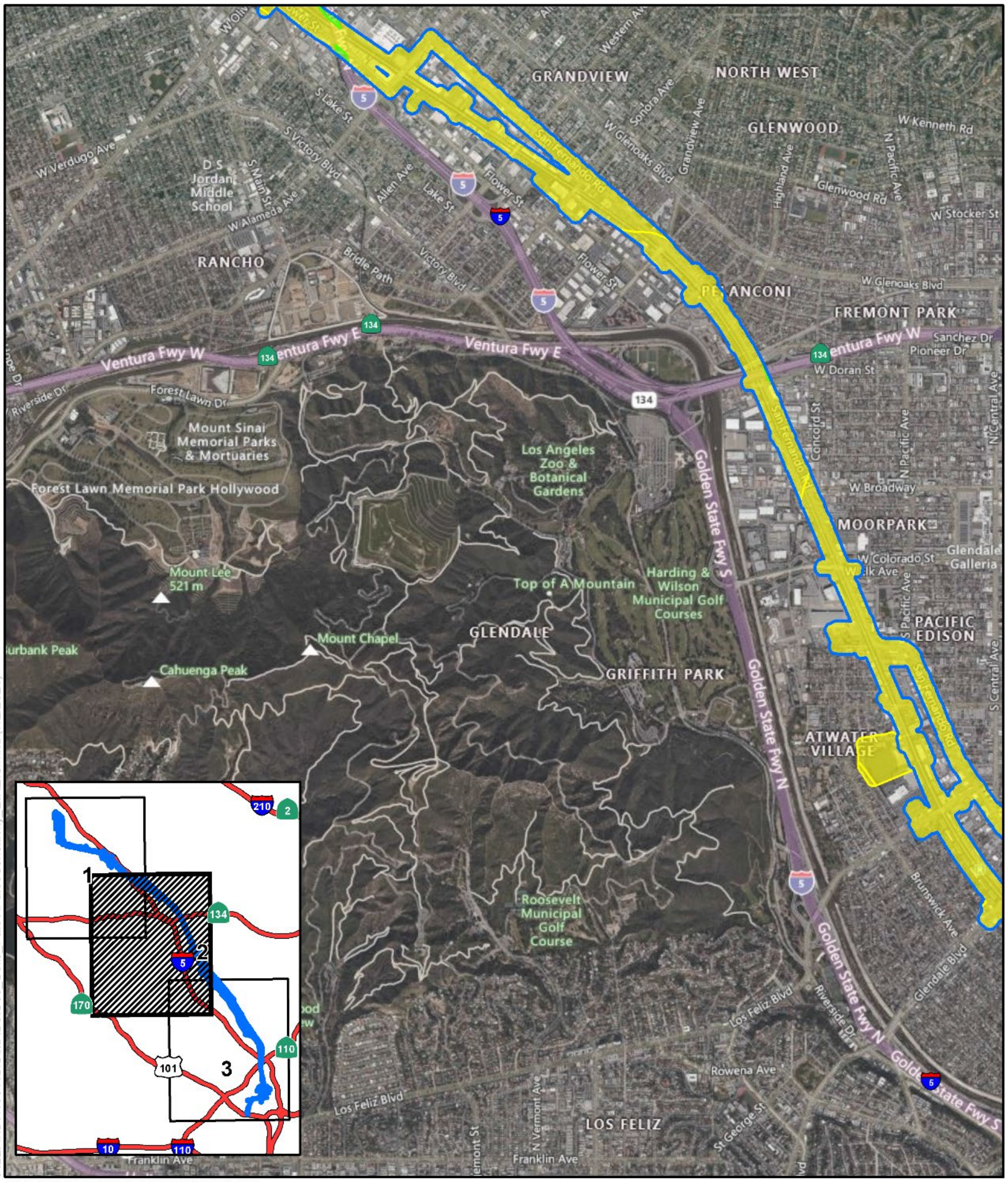
N

0 1,750 3,500 Feet

0 533 1,066 Meters

Figure 3.9-11 Paleontological Sensitivity Map

(Sheet 1 of 3)



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SOURCE: Bing (2020);CHSRA (6/2021)

N

0 1,750 3,500 Feet

0 533 1,066 Meters

Paleontological Resources Resource Study Area

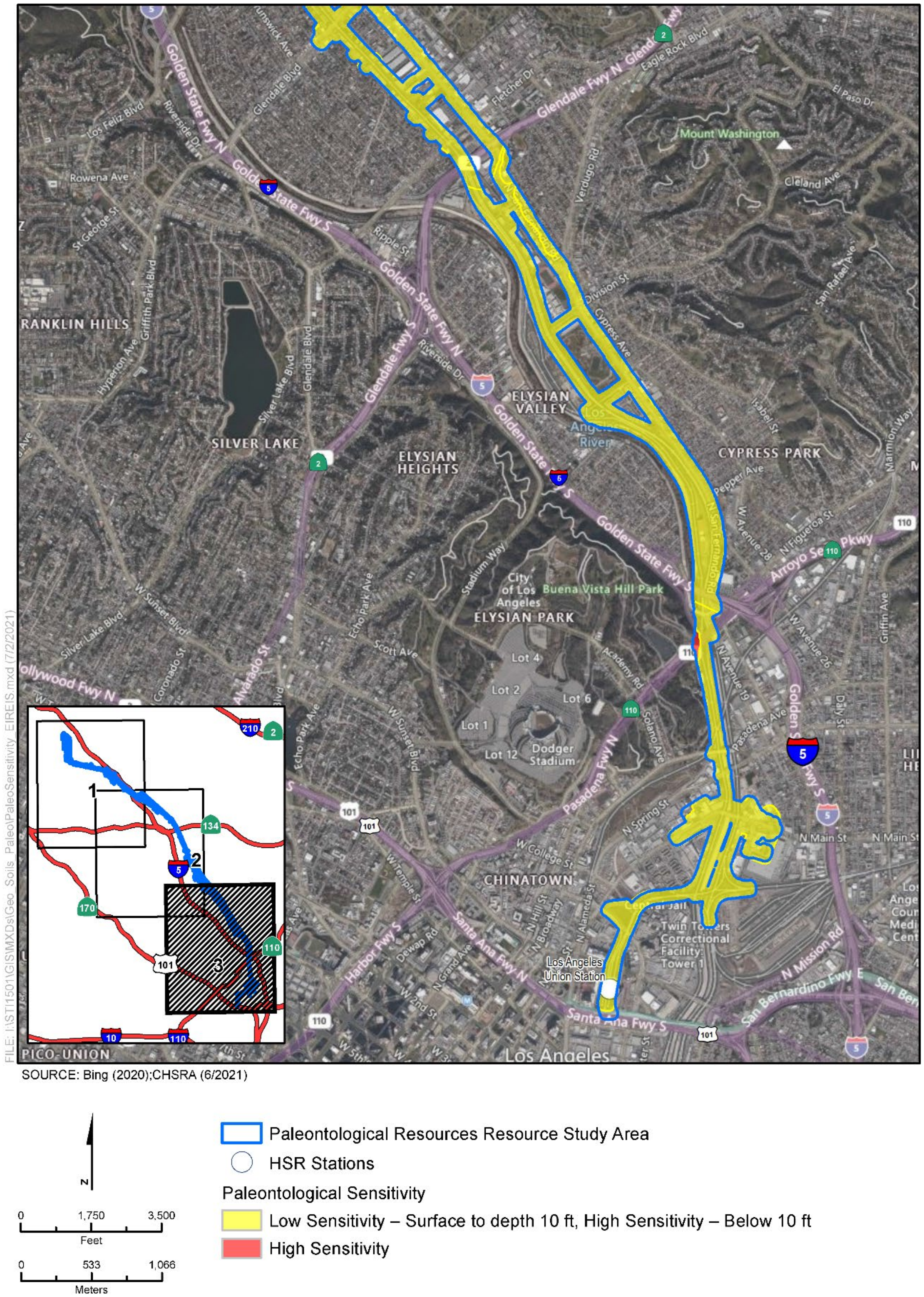
Paleontological Sensitivity

No Sensitivity

Low Sensitivity – Surface to depth 10 ft, High Sensitivity – Below 10 ft

Figure 3.9-11 Paleontological Sensitivity Map

(Sheet 2 of 3)



SOURCE: Bing (2020);CHSRA (6/2021)

Figure 3.9-11 Paleontological Sensitivity Map

(Sheet 3 of 3)

However, these deposits likely overlie older, Pleistocene deposits at undetermined depths throughout the paleontological resources RSA. Unconsolidated sediments of brown to brownish-gray silt, sand, and gravel, consistent with the Alluvial Fan Deposits, were noted in the paleontological resources RSA in some areas of exposed ground in Rio de Los Angeles State Park and Cypress Park in the city of Los Angeles (Authority 2021b).

Although Holocene (less than 11,700 years ago) deposits, such as the Alluvial Fan Deposits in the paleontological resources RSA, can contain remains of plants and animals, only those from the middle to early Holocene (4,200 to 11,700 years ago; Cohen et al. 2021) are considered scientifically important (SVP 2010). Scientifically important fossils from middle to early Holocene deposits are not very common, and the LACM has no records of vertebrate fossil localities from Holocene deposits within or surrounding the paleontological resources RSA. These Holocene deposits likely overlie older, Pleistocene deposits, which have produced scientifically important fossils elsewhere in the County and the region (Jefferson 1991a, 1991b; Miller 1971; Reynolds and Reynolds 1991; Springer et al. 2009). These older deposits span the end of the Rancholabrean North American Land Mammal Age, which dates from 11,000 to 240,000 years ago (Sanders et al. 2009) and was named for the Rancho La Brea fossil site in central Los Angeles. The presence of *Bison* defines the beginning of the Rancholabrean North American Land Mammal Age (Bell et al. 2004), but fossils from this time also include other large and small mammals, reptiles, fish, invertebrates, and plants (Jefferson 1991a, 1991b; Miller 1971; Reynolds and Reynolds 1991; Springer et al. 2009).

Although the LACM has no records of vertebrate fossil localities from Pleistocene deposits within the paleontological resources RSA, the museum has many records from Pleistocene deposits in the area surrounding the paleontological resources RSA. At the northern end of the paleontological resources RSA in the San Fernando Valley, near the intersection of San Fernando Road and Lankershim Boulevard, LACM Locality 1146 produced fossils of mastodon (*Mammut*), horse (*Equus*), and camel (Camelidae) from depths of approximately 160 to 170 feet below grade (Authority 2016a). LACM Locality 6970 is located along Lankershim Boulevard just east of Tujunga Wash and just north of the Los Angeles River in an unincorporated area of the county. This locality was collected during excavation of the Los Angeles County Metropolitan Transportation Authority (Metro) Red Line Universal City Tunnel at approximately 60 to 80 feet below grade. Specimens of ground sloth (*Glossotherium harlani*), elephant (Proboscidea), camel (*Camelops hesternus*), and bison (*Bison antiquus*) were found at this locality. Farther south along Lankershim Boulevard and south of the Los Angeles River in an unincorporated area of the county, additional localities were collected during the Metro Red Line station and tunnel excavation at depths of 40 to 60 feet below grade. These localities, LACM Locality 6306, LACM Locality 6385, and LACM Locality 6386, yielded specimens of stickleback fish (Gasterosteidae), frogs (*Rana,* Hylidae), lizards (*Gerrhonotus*, *Uta*), snakes (*Thamnophis*, *Tantilla*), bird (Aves), shrew (*Sorex*), rabbit (*Sylvilagus*), and rodents (*Perognathus*, *Thomomys*, *Dipodomys*, *Microtus*, and *Peromyscus*). Also during excavations for the Metro Red Line near the intersection of Hollywood Boulevard and Western Avenue, fossils of mastodon (*Mammut*), horse (*Equus*), camel (*Camelops*), and bison (*Bison*) were recovered from depths of between 47 and 80 feet below grade at LACM Localities 6297–6300 (Authority 2016a).

Along the central portion of the paleontological resources RSA east of Eagle Rock Boulevard just south of York Boulevard in the city of Los Angeles, LACM California Institute of Technology Locality 342 produced specimens of turkey (*Parapavo californicus*) and a rare, nearly complete mammoth (*Mammuthus*) from a depth of 14 feet below the surface. Farther south near the paleontological resources RSA close to the intersection of Workman Avenue and Alhambra Avenue, excavations for a storm drain discovered LACM Locality 1023, which yielded turkey (*Parapavo californicus*), saber-toothed cat (*Smilodon fatalis*), horse (*Equus*), and deer (*Odocoileus*). Near the intersection of Mission Road and Daly Street in the city of Los Angeles, at a depth of 20 to 35 feet below the surface, LACM Locality 2032 produced specimens of pond turtle (*Emys marmorata*), ground sloth (*Paramylodon harlani*), mastodon (*Mammut americanum*), mammoth (*Mammuthus imperator*), horse (*Equus*), and camel (*Camelops*). West of the paleontological resources RSA near the intersection of U.S. Route 101 and S Vermont Avenue in the city of Los Angeles, LACM Locality 3250 produced mammoth (*Mammuthus*) remains at a depth of 8 feet below grade (Authority 2016b).

During excavation for the Metropolitan Water District Southern California Headquarters facility at LAUS, fossilized wood, pollen, and spores were recovered from University of California Museum of Paleontology Locality PB98033 at depths of approximately 22 to 25 feet below grade (Authority 2016b). These plant fossils were dated to approximately 5,020 +/- 80 years ago (middle Holocene), and the Holocene/Pleistocene boundary in this area was inferred to be found at approximately 30 feet below grade (Authority 2016b). During excavation for the Metro Red Line tunnel immediately west of LAUS, bison (*Bison*) fossils were recovered from an uncatalogued fossil locality approximately 35 to 55 feet below grade (Authority 2016b). Southwest of the paleontological resources RSA and near the intersection of S Hill Street and W 12th Street in the city of Los Angeles, LACM Locality 1755 produced a specimen of horse (*Equus*) at a depth of 43 feet below grade (Authority 2016b; Metro 2016). A little farther southwest of the paleontological resources RSA, near the intersection of S Western Avenue and W 46th Street, LACM Locality 7758 yielded specimens of three-spined stickleback (*Gasterosteus aculeatus*), meadow vole (*Microtus*), deer mouse (*Peromyscus*), pocket gopher (*Thomomys*), and pocket mouse (*Perognathus*) at a depth of 16 feet below grade (Metro 2016). Southeast of the paleontological resources RSA, along E 26th Street and in the area of the intersection of Atlantic Avenue and I-710 in the city of Vernon, LACM Localities 7701 7702, 17869, and 17870 produced a large and diverse assemblage of animals from depths of 11 to 34 feet below grade. The specimens recovered from these four localities represent many species of ostracods, gastropods, bivalves, bony fish, salamanders, lizards, snakes, birds, rabbits, and rodents (Authority 2016b; Metro 2016).

Near LAUS, the depth of the Holocene/Pleistocene boundary has been inferred to be at a depth of approximately 30 feet below grade (Authority 2016b). However, the exact depth of the Holocene/Pleistocene boundary is not known throughout the entire paleontological resources RSA and, as noted in the fossil localities detailed above, Pleistocene fossils have been recovered from shallower depths elsewhere near the paleontological resources RSA, supporting the fact that the depth for this boundary varies greatly across the Los Angeles Basin. Based on the shallowest depths at which Pleistocene fossils were found closest to the paleontological resources RSA (e.g., *Mammuthus* remains 8 feet below grade approximately 3.5 miles west of the paleontological resources RSA, a nearly complete *Mammuthus* skeleton at 14 feet below the surface approximately 1.5 miles east of the paleontological resources RSA, and a large assemblage of invertebrates and vertebrates 11 to 34 feet below grade approximately 5 miles southeast of the paleontological resources RSA), it is inferred that Pleistocene deposits may be encountered in the paleontological resources RSA beginning at a depth of approximately 10 feet. Therefore, the Alluvial Fan Deposits are assigned low paleontological sensitivity from the surface to a depth of 10 and high sensitivity below that mark.

Young Alluvial Fan Deposits, Undivided

The Young Alluvial Fan Deposits are mapped over portions of the paleontological resources RSA, from approximately Cohasset Street to Grandview Avenue in the cities of Burbank and Glendale, as well as from approximately Broadway/Brazil Street to SR 2 in the cities of Glendale and Los Angeles. The field inspection noted unconsolidated grayish-brown silt and sand, consistent with the Young Alluvial Fan Deposits, undivided, in some areas of exposed ground in the paleontological resources RSA in Gross Park in the city of Burbank, as well as Griffith Manor Park and Pelanconi Park in the city of Glendale (Authority 2021b).

The Young Alluvial Fan Deposits, undivided, are Holocene and late Pleistocene in age. Although Holocene (less than 11,700 years ago) deposits can contain remains of plants and animals, only those from the middle to early Holocene (4,200 to 11,700 years ago; Cohen et al. 2021) are considered scientifically important (SVP 2010). Scientifically important fossils from middle to early Holocene deposits are not very common, and the LACM has no records of vertebrate fossil localities from Holocene deposits within or surrounding the paleontological resources RSA. The older Pleistocene deposits in this geologic unit have produced scientifically important fossils elsewhere in the county and the region (see discussion above on Alluvial Fan Deposits). Although the exact depth of the Holocene/Pleistocene boundary is not known throughout the paleontological resources RSA, based on the shallowest depth at which Pleistocene fossils were found near the paleontological resources RSA, it is inferred that Pleistocene deposits may be encountered beginning at a depth of approximately 10 feet. Therefore, these deposits are assigned low paleontological sensitivity from the surface to a depth of 10 feet and high sensitivity below that mark.

Puente Formation

The Puente Formation is mapped within the paleontological resources RSA along Elysian Park Drive from approximately SR 110 to N Broadway in the city of Los Angeles (Authority 2021b). Based on lithology, depositional structures, and faunal comparisons, the rocks of the Puente Formation in this area are inferred to have been deposited as part of a submarine fan in water several thousand feet deep. The field inspection in the paleontological resources RSA noted exposures of light brown, fine-grained sandstone, consistent with rocks of the Puente Formation, at Elysian Park in the city of Los Angeles (Authority 2021b).

Scientifically important paleontological resources have been recovered from the late Miocene to early Pliocene sandstones, siltstones, and shales of the Puente Formation. In the Elysian Park Hills area, Lamar (1970) reported 12 genera of fossil fish from eight localities. To the southeast in the Puente Hills, this formation has produced significant fossil remains, including fish, marine mammals (mostly whales), invertebrates, and plants (Eisentraut and Cooper 2002). The deep-water shales of the Puente Formation in the Peralta Hills in southeastern Anaheim, Orange County, yielded rare fossils of hexactinellid sponges, the first of their kind from the Miocene in California and one of few known from the Miocene in all of North America (Rigby and Albi 1996). In the Santa Ana Mountains, invertebrates, such as bivalves, gastropods, and barnacles (Schoellhamer et al. 1981), as well as some vertebrates have been recovered from strata of the Puente Formation. Moreover, to the east in Riverside County, these deposits have yielded less commonly preserved invertebrate fossils like shrimp and crabs, in addition to bivalves, microfossils, plants, and marine mammals (Feldmann 2003).

The fossil locality search through the LACM revealed several localities near or within the paleontological resources RSA. LACM Locality 4967 is a general Elysian Park locality, which encompasses a large area, likely because a more precise location of the fossil(s) recovered is not known. As such, the paleontological resources RSA passes through this general locality, which produced the holotype of a fossil herring (*Clupea tiejei*). To the east of the paleontological resources RSA and south of I-110, between the Los Angeles River and I-5, LACM Locality 7507 produced a specimen of snake mackerel (*Thyrsocles kriegeri*). Also east of the paleontological resources RSA on the southwestern part of Mt. Washington, LACM Locality 1880 yielded a suite of bony fish, including hatchetfish (*Argyropelecus bullockii*), bristlemouth (*Cyclothone*), herring (*Etringus*), rockfish (Scorpaenidae), extinct deep-sea fish (*Chauliodus*), slickheads (Alepocephalidae), cod (*Eclipes*), and croaker (*Lompoquia*). In Lincoln Heights, LACM Locality 3882 produced the holotype of an early baleen whale (*Mixocetus elysius*), which is one of the most complete fossil whale skulls known from California, according to the LACM.

The marine rocks of the Puente Formation in the paleontological resources RSA were deposited in the same environment and have similar lithologies to the fossiliferous strata of the Puente Formation found elsewhere in the region. Therefore, rocks of the Puente Formation in the paleontological resources RSA have the potential to yield similar fossils, which would be useful for taxonomic, evolutionary, and paleoecological (defined as related to the interactions of ancient life forms and their environment) studies. Moreover, because the rocks of the Puente Formation record depositional and tectonic changes that occurred in the Los Angeles Basin through the late Miocene to early Pliocene, fossils recovered from the paleontological resources RSA could be beneficial for biostratigraphic studies and correlating geologic units across this basin. This information would ultimately present a clearer, more complete picture of the geologic history of Southern California. Because these deposits have the potential to yield scientifically significant paleontological resources, they are assigned high paleontological sensitivity.

3.9.6 Environmental Consequences

3.9.6.1 Overview

This section evaluates how the No Project Alternative and the HSR Build Alternative could affect GSSPR. The impacts of the HSR Build Alternative are described and organized as follows:

- **Construction Impacts**
  - Impact GSSPR #1: Surface Fault Rupture during Construction
  - Impact GSSPR #2: Seismic Ground Shaking during Construction
  - Impact GSSPR #3: Liquefaction and Other Types of Seismically Induced Ground Failure during Construction
  - Impact GSSPR #4: Seismically Induced Flooding due to Dam Failure, Seiche, or Tsunami during Construction
  - Impact GSSPR #5: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Construction
  - Impact GSSPR #6: Soil Erosion during Construction
  - Impact GSSPR #7: Unstable or Collapsible Soils during Construction
  - Impact GSSPR #8: Ground Subsidence during Construction
  - Impact GSSPR #9: Difficult Excavation Related to Encountering Cobbles or Boulders during Construction
  - Impact GSSPR #10: Soil Corrosion and Expansion Hazards during Construction
  - Impact GSSPR #11: Availability of Mineral Resources during Construction
  - Impact GSSPR #12: Potential Exposure to Hazardous Gases during Construction
  - Impact GSSPR #13: Geologic Units Sensitive for Paleontological Resources during Construction
- **Operations Impacts**
  - Impact GSSPR #14: Surface Fault Rupture during Operation
  - Impact GSSPR #15: Seismic Ground Shaking during Operation
  - Impact GSSPR #16: Liquefaction and Other Types of Seismically Induced Ground Failure during Operation
  - Impact GSSPR #17: Seismically Induced Flooding due to Dam Failure, Seiche, or Tsunami during Operation
  - Impact GSSPR #18: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Operation
  - Impact GSSPR #19: Soil Erosion during Operation
  - Impact GSSPR #20: Unstable or Collapsible Soils during Operation
  - Impact GSSPR #21: Ground Subsidence during Operation
  - Impact GSSPR #22: Difficult Excavation Related to Encountering Cobbles or Boulders during Operation
  - Impact GSSPR #23: Soil Corrosion and Expansion Hazards during Operation
  - Impact GSSPR #24: Availability of Mineral Resources during Operation

- Impact GSSPR #25: Potential Exposure to Hazardous Gases during Operation
- Impact GSSPR #26: Geologic Units Sensitive to Paleontological Resources during Operation

3.9.6.2 No Project Alternative

Under the No Project Alternative, recent development trends within the Burbank to Los Angeles Project Section are anticipated to continue, leading to impacts on and from geology, soils, seismicity, and paleontological resources. Effects on anticipated infrastructure and development include localized deposits of soils that have low bearing capacity or exhibit excessive settlement under load. 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.

The infrastructure and development projects anticipated under the No Project Alternative carry risks on public safety and on the potential for property damage caused by geology, soils, and seismicity. Risks to infrastructure and developments include localized deposits of soils that have low bearing support or exhibit excessive settlement under load, or 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. Conversely, 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 use of older buildings to accommodate the increasing population could present a risk during a seismic event, as these buildings were typically built to less stringent standards.

Future development projects would not affect seismicity. However, the increasing population could result in development in less suitable areas 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 for adherence to geotechnical and stability regulations and would be designed to avoid or minimize effects.

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

3.9.6.3 High-Speed Rail Build Alternative

Construction Impacts

Construction of the HSR Build Alternative would involve activities such as (but not limited to) demolition of existing structures, clearing, and grubbing; reduction of permeable surface area; handling, storing, hauling, excavating, and placing fill; possible pile driving; and construction of aerial structures, bridges, road modifications, utility upgrades and relocations, HSR electrical systems, and railbeds. Chapter 2, Alternatives, further describes construction activities.

Geology, Soils, and Seismicity

Impact GSSPR#1: Surface Fault Rupture during Construction
As indicated in Section 3.9.5.2, surface fault rupture has the potential to occur at the locations where the HSR Build Alternative crosses known potentially hazardous faults. Ground surface rupture is a

possibility either within or in close proximity to the HSR Build Alternative. Of specific concern are the Verdugo, Hollywood, Raymond, Elysian Park (Upper) Faults and Unnamed Fault L66a, all of which the HSR Build Alternative alignment crosses or runs in close proximity to, as shown on Figure 3.9-6. Neither the proposed location of the Burbank Airport Station nor LAUS are on any known faults.

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that a surface fault rupture event would coincide with construction activities is low. The project also includes IAMFs to minimize the effects on people and structures in the event that surface fault rupture occurs during construction. Prior to construction (during final design), potentially hazardous faults crossed by the HSR Build Alternative would be evaluated (see GEO-IAMF#7) by conducting field investigations to establish updated estimates of levels of ground motion.

Preparation of a CMP stating how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would minimize risks associated with surface fault rupture. Standard earthquake safety measures would be implemented to protect construction workers and other individuals living and working in the vicinity of the HSR Build Alternative, including the early action projects.

Therefore, the project would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of surface fault rupture during construction along the alignment or at stations.

CEQA Conclusion

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that a surface fault rupture event would coincide with construction activities is low. In the event a surface fault rupture occurred during construction, the project also includes IAMFs to minimize the effects on people and structures. GEO-IAMF#1 requires preparation of a CMP stating how the contractor would address geologic constraints, and Geo-IAMF#10 requires that construction procedures adhere to accepted engineering and safety guidelines and standards. Standard earthquake safety measures would be implemented to protect construction workers and other individuals living and working in the vicinity of the HSR Build Alternative. Given the low potential for surface fault rupture during construction and the safety measures of the IAMFs in the event a rupture occurs, construction of the HSR Build Alternative would not directly or indirectly cause the potential risk of loss of life, injuries, or destruction as a result of surface fault rupture beyond what people are exposed to in the area's current environment. As such, there would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#2: Seismic Ground Shaking during Construction

Faults in the seismicity RSA have produced historic earthquakes with magnitudes up to 7.79. The level of ground shaking could vary along the HSR Build Alternative (including the early action projects), depending on the amount of ground motion amplification or deamplification within specific soil layers.

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010), and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that significant seismic ground shaking would coincide with construction activities is low. The project also includes IAMFs to minimize the effects on people and structures in the event that seismic ground shaking occurs during construction. Preparation of a CMP stating how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would minimize risks associated with surface fault rupture. Standard earthquake safety measures would be implemented to protect construction workers and other individuals living and working in the vicinity of the HSR Build Alternative. The HSR Build Alternative would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of seismic ground shaking during construction.

CEQA Conclusion

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010), and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that significant seismic ground shaking would coincide with construction activities is low. The project includes IAMFs to minimize the effects on people and structures should seismic ground shaking occur during construction. Preparation of a CMP stating how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would minimize risks associated with seismic ground shaking. Standard earthquake safety measures would be implemented to protect construction workers and other individuals living and working in the vicinity of the HSR Build Alternative. With implementation of GEO-IAMF#1 and GEO-IAMF#10, the HSR Build Alternative would not directly or indirectly cause the potential risk of loss of life, injuries, or destruction as a result of seismic ground shaking during construction beyond the level people currently experience in the resource hazards RSA. Therefore, there would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#3: Liquefaction and Other Types of Seismically Induced Ground Failure during Construction

The expected level of ground shaking along the HSR Build Alternative (including the early action projects) is high because it is near or crossed by faults with large earthquake potential. However, for liquefaction to take place, groundwater must be present. According to the CGS (2010), the area occupied by the Burbank Airport Station is not designated as susceptible to liquefaction. However, the northern section of the HSR Build Alternative, south of the Burbank Airport Station to SR 134, is designated as susceptible to liquefaction, as well as the southern segment of the HSR Build Alternative from approximately 0.4 mile south of SR 2 to and including LAUS. The new crossings and bridges that would be in the liquefaction areas include Verdugo Wash and Kerr Road. Additionally, the Sonora Avenue, Grandview Avenue, Flower Street, and Main Street grade separations, which are early action projects, are in areas subject to liquefaction. According to CGS historical high groundwater maps, there is shallow groundwater (less than 50 feet below ground surface) along the entire alignment, except at the Burbank Airport Station, where it is known to be at depths greater than 150 feet below ground surface. The actual depth of groundwater would be verified during geotechnical borings during the final design phases for the HSR Build Alternative and the downtown Burbank station and Main Street grade separation early action projects. In areas where groundwater and soil conditions create risks of liquefaction and other types of seismically induced ground failure, deep foundations are typically used for buildings and structures to provide support through liquefied layers.

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that a liquefaction or other seismically induced ground failure event would coincide with construction activities is low. The project includes IAMFs to minimize the effects on people and structures in the event that liquefaction or other types of seismically induced ground failures occur during construction. Preparation of a CMP stating how the contractor would address geologic constraints (GEO-IAMF#1) and preparation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction (GEO-IAMF#10) would minimize risks associated with liquefaction and seismically induced slope failure. Detailed slope stability evaluations would be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures.

CEQA Conclusion

Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010), and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that a liquefaction or other seismically induced ground failure event would coincide with construction activities is low. The project includes several IAMFs to minimize the effects on people and structures in the event that liquefaction or other types of seismically induced ground failures occur during construction. Preparation of a CMP stating how the contractor would address geologic constraints (GEO-IAMF#1) and preparation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction (GEO-IAMF#10) would minimize risks associated with liquefaction and seismically induced slope failure. Detailed slope stability evaluations would be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures. The actual depth of groundwater would be verified during geotechnical borings conducted in the final design phases of the HSR Build Alternative and the early action projects. At locations where final design determined groundwater and soil conditions indicate there is a potential for strength loss from liquefaction, deep foundations are typically used to provide structural support through liquefied layers. Implementation of GEO-IAMF#1 and GEO-IAMF#10 would ensure that the HSR Build Alternative (including the early action projects) would not directly or indirectly cause potential risk of loss of life, injuries, or destruction as a result of liquefaction or other types of seismically induced ground failure during construction beyond the level people currently experience in the resource hazards RSA. Therefore, there would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#4: Seismically Induced Flooding due to Dam Failure, Seiche, or Tsunami during Construction

Seismically induced flooding is caused by failure of water-retaining structures such as dams, reservoirs, levees, or large storage tanks or by seiche or tsunami waves during a seismic event. As noted in Section 3.9.5.1, due to the distance to the nearest dam (5.9 miles) and nearest ocean (more than 14 miles), the risk of flooding of the HSR Build Alternative (and the early action projects) from seiche or tsunami is low. Portions of the resource hazards RSA are within the flood inundation zones of Hansen Dam and Eagle Rock Dam, as well as several reservoirs within and near the resource hazards RSA.

Although seismically induced dam or reservoir failure is possible, due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (i.e., estimated to be less than 10 years, see Construction Schedule in Table 2-17) relative to recurrence intervals, the probability that a seismically induced dam failure event would coincide with construction activities is low. 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. The risk of exposure to flooding of the HSR Build Alternative (including the early action projects) 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 hazards RSA. However, in the event of seismically-induced flooding, implementation of the construction BMPs, guidelines, and standards outlined in GEO-IAMF#10 would minimize risks to people and structures during construction.

CEQA Conclusion

As noted above, the potential for a seismically induced flooding event to affect the HSR Build Alternative (including the early action projects) as a result of dam failure, seiche, or tsunami is low, However, in the event that seismically induced dam failure, seiche, or tsunami occurs during construction, construction BMPs, standards, and guidelines outlined in GEO-IAMF#10 would minimize the effects on people and structures within the resource hazards RSA. The HSR Build Alternative (including the early action projects) would not directly or indirectly cause potential risk of loss of life, injuries, or destruction during construction due to seismically induced dam failure, seiche, or tsunami beyond what people currently experience in the resource hazards RSA. Therefore, there would be a less than significant impact under CEQA. No mitigation is required.

Impact GSSPR#5: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Construction

Portions of the resource hazards RSA in the vicinity of Elysian Park and the Los Angeles River currently contain slopes, but no grading is proposed at these existing slopes. Based on the level topography at and adjacent to the majority of the track alignment for the HSR Build Alternative, the potential for landslide hazards is low. However, a small area at the south end near the I-5/SR 110 interchange (near Elysian Park), a portion in the central area aligning with Griffith Park, and a portion at the north end northeast of Hollywood Burbank Airport have been identified by CGS as being prone to landslides, where an increased potential for slope failure exists. The area where the SEM tunnel would be constructed is outside of the areas that have been identified by CGS as prone to landslides.

Construction of the HSR Build Alternative includes several cut and fill areas. Construction of the HSR Build Alternative or early action projects on soft or loose soils could result in on- or off-site slumps, instability of cut-and-fill slopes required for the HSR tracks, or collapse of retaining structures used for retained fills or retained cuts. These potential slumps and slope failures could endanger people and structures if an earthquake were to occur during construction. The effects would be highly dependent on the size of the earthquake and the specific state of construction of various features at the moment the earthquake occurred. Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (estimated to be less than 10 years [see the construction schedule in Table 2.17 in Chapter 2 of this EIR/EIS]) relative to recurrence intervals, the probability that a seismically induced slope failure event would coincide with construction activities is low. Project features would minimize the potential increased risks associated with landslides through implementation of conventional engineering methods to remove or stabilize landslides. Detailed landslide evaluations would be conducted in landslide-prone areas to determine appropriate engineering solutions prior to construction, in accordance with relevant design guidelines and standards, such as the American Railway Engineering and Maintenance-of-Way Association, the Federal Highway Administration, and Caltrans (GEO-IAMF#10). Landslide stability would be assessed using the most recently updated Authority seismic design criteria (GEO-IAMF#7). Following GEO-IAMF#1, prior to construction, a CMP would be prepared that would include design measures such as structural solutions (e.g., tie backs, soil nails, retaining walls, debris barriers) or earthwork solutions (e.g., ground improvement, regrading/rebuilding of slopes) to reduce or avoid the hazards associated with landslides and earthquake-induced landslides. Implementation of project features and actions before and during construction would avoid increasing exposure of people or structures to potential loss of life, injuries, or destruction beyond what they are exposed to currently in the area's environment due to earthquake-induced landslides**.**

CEQA Conclusion

The majority of the track alignment for the HSR Build Alternative is on level topography and does not contain slopes or the potential for landslides, with the exception of the following small areas where an increased potential for slope failure exists:

1. At the south end near the I-5/SR 110 interchange (near Elysian Park)
2. In the central area aligning with Griffith Park
3. At the north end northeast of Hollywood Burbank Airport

In addition, construction of the HSR Build Alternative and early action projects include several cut and fill areas. Due to the design recurrence intervals of seismic events (i.e., estimated recurrence period of 2,475 years) from Technical Memorandum TM 2.10.6 (Authority 2010) and the short duration of construction activities (estimated to be less than 10 years [see the construction schedule in Table 2.17 in Chapter 2 of this EIR/EIS]) relative to recurrence intervals, the probability that a seismically induced slope failure event would coincide with construction activities is low. No grading is proposed on existing slopes within the resource hazards RSA, and project features would minimize the potential increased risks associated with landslides. These project features include assessing landslides using the most recently updated Authority seismic design criteria, applying geotechnical engineering practices to design and construction, including the sequential excavation method (SEM) that would be employed to construct underneath Hollywood Burbank Airport, and conforming to guidelines specified by relevant transportation and building agencies (e.g., the American Railway Engineering and Maintenance-of-Way Association, the Federal Highway Administration, and Caltrans) (GEO-IAMF#1, GEO-IAMF#7, and GEO-IAMF#10). Specifically with respect to SEM, the excavation using SEM would require the use of stiff pre-support, such as a grouted pipe canopy, and face support, such as face dowels and shotcrete, multiple drifts and short round lengths, and early installation of the center wall. These measures are to control ground loss ahead of the face and face stability. As such, the HSR Build Alternative would not cause direct or indirect risks to life and property from secondary seismic hazards, slope failure, or landslides during construction beyond the level people currently experience in the RSA. Therefore, the impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#6: Soil Erosion during Construction

Because the HSR Build Alternative (including the early action projects) is in an urban area and topsoil is not present, the HSR Build Alternative would not result in a loss of topsoil. However, construction activities, such as grading and excavation, could cause or accelerate soil erosion. If exposed soils are not protected from wind or water erosion, such as when work areas are cleared of vegetation and materials are stockpiled, both the exposed work area and any stockpiles could erode and cause adverse effects on air and water quality. There is potential for increased stormwater runoff as a result of the construction of temporary, impermeable work surfaces. The implementation of GEO-IAMF#1, GEO-IAMF#10, and HYD-IAMF#3 would minimize the effects of soil erosion. GEO-IAMF#1 requires the preparation of a CMP to address geological and geotechnical constraints and resources. HYD-IAMF#3 requires that the construction contractor comply with the State Water Resources Control Board Construction General Permit to prepare a Stormwater Pollution Prevention Plan which would identify BMPs to minimize soil erosion during construction. There are several methods for controlling water and wind erosion of soils. These include the use of mulches, revegetation, and covering areas with geotextiles. Where runoff velocity could be high, riprap and check dams could be used to reduce erosion. These methods would be implemented as appropriate and in coordination with other erosion, sediment, stormwater management, and fugitive dust control measures. Additionally, standard construction practices, such as those listed in the Caltrans *Construction Site Best Management Practices (BMPs) Manual* (Caltrans 2003b) and the *Construction Site Best Management Practice Field Manual and Troubleshooting Guide* (Caltrans 2003a) as outlined in GEO-IAMF#10, would be implemented to minimize the potential for erosion. These could include soil stabilization, watering for dust control, perimeter silt fences, and sediment basins. With the implementation of project IAMFs, the HSR Build Alternative would minimize impacts of soil erosion during construction.

CEQA Conclusion

Because this is an urban area and topsoil is not present, the HSR Build Alternative would not result in a loss of topsoil. The implementation of GEO-IAMF#1, GEO-IAMF#10, and HYD-IAMF#3 would minimize the effects of soil erosion. GEO-IAMF#1 requires the preparation of a CMP to address geological and geotechnical constraints and resources. HYD-IAMF#3 requires that the construction contractor comply with the State Water Resources Control Board Construction General Permit to prepare a Stormwater Pollution Prevention Plan that would identify BMPs to minimize soil erosion during construction. Additionally, standard construction practices listed in the manuals outlined in GEO-IAMF#10 would be implemented to minimize the potential for erosion. With implementation of the above-stated IAMFs during construction of the HSR Build Alternative would not result in substantial soil erosion. Therefore, the impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#7: Unstable or Collapsible Soils during Construction

Localized deposits of soft or loose soils could occur at various locations throughout the HSR Build Alternative footprint. Project construction could cause soil settlement if imposed loads cause compression of the underlying materials. This is most problematic at locations where coarse-grained soils exist and have not previously been consolidated by loads of the same levels as would be imposed by new construction. Such loads would be experienced at approach fills for embankments constructed to support track structural sections (e.g., ballast and subballast placed to meet track grade requirements).

Geotechnical explorations to be undertaken prior to final design and prior to construction would identify locations with the potential for settlement. In such locations, where subsurface conditions may not be capable of supporting the additional load induced by additional fill, engineering design features that address soft deposits of silty or clay soils would be incorporated, such as pre-loading to accelerate settlement or adding wick drains if applicable. Application of the engineering design features would reduce the potential for soil settlement. Preparation of a CMP addressing how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction (GEO-IAMF#10) would minimize risks associated with collapsible soils.

Project IAMFs would minimize effects resulting from potentially unstable soils that may be present within the project footprint or from soils rendered unstable by heavy loads placed during construction. As a result, these IAMFs would minimize the potential to expose people or structures to potential loss of life, injuries, or destruction.

CEQA Conclusion

Preparation of a CMP addressing how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction (GEO-IAMF#10) would minimize risks associated with collapsible soils. As a result, during construction of the HSR Build Alternative, the project would not directly or indirectly cause potential loss of life, injuries, or destruction as a result of collapsible soils during construction. Therefore, the impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#8: Ground Subsidence during Construction

Although oil extraction has occurred in the resource hazards RSA, ground subsidence as a result of oil extraction is not known to have occurred (USGS 2016b). Additionally, dewatering groundwater during construction would not have an impact on existing groundwater levels or supplies, as discussed in Section 3.8.6, Environmental Consequences, in Section 3.8, Hydrology and Water Resources, of this EIR/EIS.

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. The Authority addresses subsidence in its CMP for its design and construction processes (GEO-IAMF#1). For the initial design, survey monuments were installed to establish a datum and to set an initial track profile. In the construction phase, the design-build contractors for track bed preparation conduct topographic surveys for preparation of final design. Because subsidence could have occurred since the original benchmarks (survey monuments) were established, the contractor's topographic surveys would be used to help determine whether subsidence has occurred. The updated topographic surveys would also be used to establish the top of rail elevations for final design where the HSR system is outside established floodplain areas and above water surface elevations. Where the HSR system is in floodplain areas susceptible to flooding, consideration is being given to overbuild the height of the railbed in anticipation of future subsidence.

CEQA Conclusion

With implementation of a CMP as outlined in GEO-IAMF#1, the HSR Build Alternative would not cause or accelerate the potential for ground subsidence. Because it would not cause or accelerate the potential for ground subsidence, the HSR Build Alternative would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of ground subsidence during construction. Therefore, there would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#9: Difficult Excavation Related to Encountering Cobbles or Boulders during Construction

The depth to bedrock within the resource hazards RSA ranges from outcrops near Elysian Park to hundreds of feet deep at the ends of the resource hazards RSA. A comprehensive geotechnical/geological investigation program to identify the locations and depths of the bedrock formations would be performed during the final design phase to identify areas of difficult excavation. The Authority would conform to the guidelines specified by relevant transportation and building agencies and codes (GEO-IAMF#10), requiring Authority contractors to account for geotechnical properties during the HSR Build Alternative design and construction and thus address risk factors associated with difficult excavation conditions. Methods in the Caltrans *Construction Site Best Management Practices (BMPs) Manual* (Caltrans 2003a) and *Construction Site Best Management Practice Field Manual and Troubleshooting Guide* (Caltrans 2003b) related to difficult excavation conditions would be used per GEO-IAMF#10. It is anticipated that standard construction equipment would be used in excavations. With implementation of GEO-IAMF#10 and standard safety practices as outlined in the aforementioned manuals, there would not be an increased potential for injury or loss of life during construction.

CEQA Conclusion

Implementation of GEO-IAMF#10 requires the Authority to account for geotechnical properties during HSR Build Alternative design and construction. Additionally, design and construction practices would address risk factors associated with difficult excavation conditions, such as cobbles and boulders, and would not exacerbate the risks of personal injury, loss of life, or property damage in areas of difficult excavation. Therefore, the impact is less than significant and no mitigation is required.

Impact GSSPR#10: Soil Corrosion and Expansion Hazards during Construction

Soils mapped in the RSA have low to high corrosivity to concrete and moderate to high corrosivity to steel. Consequences of corrosion could include eventual loss in the structural capacity of buried steel or concrete components.

Localized areas underlain by expansive soils are likely to occur within the RSA given the regional geologic circumstances. The effects of expansive soils are more critical to at-grade track segments than to elevated structures, such as grade separations or railroad bridges, on deep foundations, retained fill, or retained cuts. The earth loads associated with at-grade segments of the HSR Build Alternative may not be sufficient to overcome swell potential, and this swell would likely be variable along the alignment, leading to differential movement of the track system. The potential for shrink-swell of expansive soils, if unchecked, represents a risk to structures.

A comprehensive geotechnical/geological investigation program conducted during final design would determine the locations of corrosive and expansive soils, as well as their deformation potential. The project includes IAMFs to minimize the effects on people and structures in the event that corrosive or expansive soils are found during geotechnical investigation. These soil conditions would be addressed during construction. Through implementation of the CMP identified in GEO-IAMF#1, the corrosive soils would have been removed, buried structures would have been designed for corrosive conditions, and corrosion-protected materials would have been used in infrastructure. Also through implementation of this CMP, shrink-swell soils would have been treated or removed. By following the design and construction BMPs, standards, and guidelines described in GEO-IAMF#10, areas with corrosive or expansive soils would be treated appropriately during construction to minimize the effects of corrosive and expansive soils.

CEQA Conclusion

The HSR Build Alternative would be constructed in areas containing corrosive and expansive soils, which would potentially expose people or structures to potential loss of life, injuries, or destruction as a result of these conditions during construction. As described above, in locations where existing soils have a potential to be corrosive to steel and concrete, the implementation of GEO-IAMF#1 would ensure that corrosive soils would be removed, buried structures would be designed for corrosive conditions, and corrosion-protected materials would be used in infrastructure. Prior to construction, GEO-IAMF#1, through a CMP, would reduce the effects caused by shrink-swell soils through soil treatment or removal of soils that exhibit high shrink-swell potential, and replacement of the excavated soils with soils that do not exhibit these characteristics. With implementation of GEO-IAMF#1, the HSR Build Alternative would not create substantial direct or indirect risks to life or property as a result of the soils' nature. Therefore, impacts would be less than significant under CEQA, and no mitigation is required.

Impact GSSPR#11: Availability of Mineral Resources during Construction

The resource hazards RSA south of San Fernando Road is predominantly zoned MRZ-2, whereas north of San Fernando is generally zoned MRZ-3. This zoning is consistent in the portions of the RSA that traverse the cities of Burbank, Glendale, and Los Angeles. Construction of the HSR Build Alternative may temporarily reduce access to existing mining facilities (refer to Table 3.9-10) or potential zoned mineral resources near the alignment. Prior to construction, the contractor would prepare a CMP addressing how the construction would minimize or avoid impacts to access locations of existing or future mines (see GEO-IAMF#1). Also, the contractor would evaluate historic and/or abandoned mines and other toxic sites to determine if any clean up or stabilization of mine tailings is required (see GEO-IAMF#4).

CEQA Conclusion

Although construction of the HSR Build Alternative may temporarily reduce access to existing mining facilities or potential mineral resources near the alignment, implementation of GEO-IAMF#1 and GEO-IAMF#4 would minimize or avoid these impacts. GEO-IAMF#1 requires preparation of a CMP to address how construction impacts to mining access would be minimized or avoided. GEO-IAMF#4 requires the contractor to evaluate historic and/or abandoned mines or other toxic sites to determine if any clean up or stabilization of mine tailings is necessary. With implementation of GEO-IAMF#4, the HSR Build Alternative would not result in the loss of availability of a locally important mineral resource recovery site. Therefore, the impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#12: Potential Exposure to Hazardous Gases during Construction

As discussed in Section 3.9.5.1, hazardous subsurface gases—including methane and hydrogen sulfide, which can occur naturally in soil, rock, or groundwater—may be found within the resource hazards RSA. For the below-grade alignment and the Burbank Airport Station, as well as the early action projects, which involve deeper excavation, construction may increase the risk of exposure to subsurface gas hazards. The resource hazards RSA southern portion traverses oil fields that have a high probability of containing methane and other hazardous subsurface gases. Based on the review of DOGGR mapped sites, the wells within or adjoining the HSR Build Alternative were either plugged and abandoned or idle, where the area has been graded and developed for roadway, commercial, or residential purposes. However, the DOGGR records indicate that some of the abandoned or idle wells could not be identified in the field, as information was missing. Therefore, for the HSR Build Alternative and the early action projects, comprehensive geotechnical/ geological investigation programs would be performed to assess the likelihood of naturally occurring hazardous gases within the area of construction and for the presence of any idle or abandoned wells that may cause significant risk to the public and environment. The implementation of GEO-IAMF#3, which requires preparation of a CMP for gas monitoring, and SS-IAMF#4, which requires inspection and abandonment or re-abandonment of wells within 200 feet of the HSR tracks, would minimize these effects on people and structures. Therefore, the project would not result in a risk or loss of life or destruction of property.

CEQA Conclusion

Construction of the below-grade alignment, the Burbank Airport Station, and the early action projects may increase the risk of exposure to subsurface gas hazards. This could result in a risk of loss of life or destruction of property. The implementation of GEO-IAMF#3, which requires preparation of a CMP for gas monitoring, and SS-IAMF#4, which requires inspection and abandonment or re-abandonment of wells within 200 feet of the HSR tracks, would minimize these effects on people and structures during construction of the HSR Build Alternative. With implementation of GEO-IAMF#3 and SS-IAMF#4, the HSR Build Alternative would not result in a substantial risk of loss of life or destruction of property due to subsurface hazardous gases. Therefore, the impact under CEQA would be less than significant and no mitigation is required.

Paleontological Resources

Impact GSSPR#13: Geologic Units Sensitive for Paleontological Resources during Construction
Destruction by breakage and crushing, typically in construction-related excavations, could pose a direct impact on surface or subsurface paleontological resources in areas identified as having paleontological sensitivity (as listed in Table 3.9-12 and depicted on Figure 3.9-11) along the HSR Build Alternative alignment. Table 3.9-13 provides an overview of geologic units sensitive for paleontological resources that would potentially be affected by construction of the HSR Build Alternative.

Table 3.9-13 Geologic Units Sensitive to Paleontological Resources Potentially Affected by Development of Project Section Components

Project Section Component	Depth of Ground Disturbance (feet)	Geologic Unit(s) Sensitive to Paleontological Resources Potentially Affected
No Project Alternative		
Various	TBD	TBD
HSR Build Alternative		
Trackwork	8	Puente Formation
Shoofly Tracks	20	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Overcrossings/Undercrossings	Less than 30	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Bridgework	50 to 120	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Relocation of Existing Oil Lines/Fiber-Optic Lines	40 to 100	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Relocation of Extraction Wells, Valve Vault, and Ancillary Infrastructure - Burbank	400	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet TBD
Relocation of Extraction Well and Ancillary Infrastructure – Glendale	225	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet TBD
Tunnel Section	60 to 90	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Trench Section	75	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Metrolink CMF: Roadway Work	25	Alluvial Fan Deposits below a depth of 10 feet
Metrolink CMF: Track Relocation	16	Alluvial Fan Deposits below a depth of 10 feet
Metrolink CMF: Facility Relocation/ Reconstruction	12 to 15	Alluvial Fan Deposits below a depth of 10 feet
Metrolink CMF: Utility Relocation	12 to 15	Alluvial Fan Deposits below a depth of 10 feet
Metrolink CMF: Retention Basin	12	Alluvial Fan Deposits below a depth of 10 feet

Project Section Component	Depth of Ground Disturbance (feet)	Geologic Unit(s) Sensitive to Paleontological Resources Potentially Affected
Station Sites		
Burbank Airport Station: Underground Portion	90	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Burbank Airport Station: Surface Features	0 to10	None
LAUS: Platforms	0	None
Ancillary and Support Facilities		
Overhead Contact System Mast Poles and Manholes	20	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet Puente Formation
Switching Station	8 to 10	None
Paralleling Station	5	None
PTC Fiber-Optic Lines	6 to 10	Puente Formation
PTC Towers	30 to 40	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet Puente Formation
Early Action Projects		
Downtown Burbank Metrolink Station: Trackwork	5	None
Downtown Burbank Metrolink Station: Parking Areas	5	None
Downtown Burbank Metrolink Station: Pedestrian Bridges	8 to 15	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Grade Separations: ▪ Sonora Avenue ▪ Grandview Avenue ▪ Flower Street ▪ Goodwin Avenue ▪ Main Street	Less than 30	Alluvial Fan Deposits below a depth of 10 feet Young Alluvial Fan Deposits, undivided, below a depth of 10 feet
Chevy Chase Drive Pedestrian Overcrossing	50 to 60	Young Alluvial Fan Deposits, undivided, below a depth of 10 feet

CMF = Central Maintenance Facility
HSR = high-speed rail
LAUS = Los Angeles Union Station
OCS = overhead contact system
PTC = positive train control
TBD = to be determined

Along the alignment, most trackwork constructed at-grade would involve excavation with general construction equipment (e.g., scrapers, trackhoes, backhoes, bulldozers) to a depth of approximately 8 feet below the current grade. Based on the shallow depth of proposed excavation for most of the trackwork (less than 8 feet below current grade), the only geologic unit sensitive to paleontological resources that most of the trackwork would potentially affect is the Puente Formation. However, excavation for the shoofly tracks to support Metrolink operations during construction of the HSR alignment would reach a depth of 20 feet. As such, excavation for the shoofly tracks may potentially affect the paleontologically sensitive Young Alluvial Fan Deposits below a depth of 10 feet.

The depth of any existing utilities would dictate the depth of excavation for all undercrossings or overcrossings and may extend up to 30 feet below grade, with the exception of the Chevy Chase Drive pedestrian overcrossing being constructed as an early action project and discussed below. For the bridgework at Verdugo Wash, Colorado Street, Los Feliz Boulevard, Glendale Boulevard, and the Los Angeles River proposed near Glendale Avenue, cast-in-drilled-hole piles would be constructed for the supports, which would be drilled to approximately 50 to 120 feet. In addition, existing oil lines and fiber-optic lines would be relocated from within the railroad right-of-way east along San Fernando Road, which parallels the railroad corridor. The relocation would require directional drilling along San Fernando Road at depths of approximately 40 to 100 feet along the alignment, with access pits approximately 12 feet wide by 300 feet long and spaced approximately every 1,000 feet. Relocation of the Superfund extraction wells, valve vault, and infrastructure in the city of Burbank would require drilling wells to depths of approximately 400 feet. Relocation of the Superfund extraction well and infrastructure in the city of Glendale would require drilling a new well to depths of up to 225 feet. Construction of all overcrossings and undercrossings, all bridgework, relocation of existing oil and fiber-optic lines, and relocation of the extraction wells, valve vault, and ancillary infrastructure may potentially affect paleontologically sensitive geologic units in all places where these activities occur. The paleontologically sensitive geologic units that may be affected include the Alluvial Fan Deposits below a depth of 10 feet and the Young Alluvial Fan Deposits, undivided, below a depth of 10 feet. Additional paleontologically sensitive geologic units may be impacted by drilling for the new extraction wells in the cities of Burbank and Glendale; however, the specific geologic units involved would need to be identified from borings conducted during the subsurface geotechnical testing program at a later design stage.

The below-grade section of the alignment beginning at the Burbank Airport Station involves excavation of a tunnel and a trench. Excavation for the tunnel section would extend to a depth of approximately 60 to 90 feet. The portion of the alignment that would travel in a trench would require excavation to a depth of 75 feet. Excavation activities for the entire below-grade section of the alignment, including the tunnel and the trench section, may affect the paleontologically sensitive Young Alluvial Fan Deposits, undivided.

At the Metrolink Central Maintenance Facility, excavation for relocation and construction of new tracks would extend to a depth of approximately 12 to 15 feet. Revision of the roadway network would involve excavation to approximately 25 feet and would use soldier pile walls with timber or concrete lagging. Excavation up to approximately 12 to 15 feet would be required for relocation or reconstruction of the train washing/reclamation building, yard pump house, and two service and inspection facilities, as well as relocation of wet and dry utilities. Lastly, construction of a retention basin would involve excavation to a depth of approximately 12 feet. All excavation activities at the Metrolink CMF, with the exception of excavation for the retention basin, may potentially affect the paleontologically sensitive Alluvial Fan Deposits below a depth of 10 feet.

Current plans for the Burbank Airport Station indicate that excavation for the underground portion, which includes the tracks, platforms, and station, is expected to extend to a depth of approximately 90 feet and may require additional specialized equipment that is yet to be determined in addition to conventional excavation equipment due to the exceptional depth. Based on the experience of the Regional Consultant, excavation for the surface features, including pick-up/drop-off facilities for private automobiles, the transit center for buses and shuttles, and surface parking areas, is inferred to extend to depths of less than 10 feet. Excavation activities for the underground portion of the Burbank Airport Station may potentially affect the paleontologically sensitive Young Alluvial Fan Deposits, undivided, below a depth of 10 feet. However, none of the excavation activities for the surface features at the Burbank Airport Station are expected to have the potential to affect paleontologically sensitive geologic units.

At LAUS, construction of the additional tracks and platforms would be completed as part of the Metro Link US Project and have been evaluated in the Metro Link US Project Final EIR, which was released in June 2019. The HSR Build Alternative would modify the tracks and install an overhead contact system (OCS). Moreover, the foundations for the OCS at LAUS would also be completed as part of the Metro Link US Project; therefore, no excavation for the OCS at LAUS would be necessary. With no excavation anticipated for the platforms or electrification systems at LAUS as part of the HSR Build Alternative, these components are not expected to affect any geologic units sensitive to paleontological resources.

Current plans indicate that ground disturbance for the mast poles for the OCS system would involve augering 3-foot-radius holes to depths of approximately 20 feet, while the manholes for the OCS would be open cuts to depths of approximately 20 feet dug with traditional excavation equipment. As such, installation of the mast poles and manholes would affect several geologic units sensitive to paleontological resources within the paleontological resources RSA, including the Alluvial Fan Deposits below a depth of 10 feet; the Young Alluvial Fan Deposits, undivided, below a depth of 10 feet; and the Puente Formation.

Ground disturbance associated with construction of the switching station north of Glendale Boulevard in the city of Los Angeles would involve traditional excavation to depths of approximately 8 to 10 feet. Ground disturbance for the paralleling station south of Main Street in the city of Los Angeles would involve traditional excavation to depths of approximately 5 feet. The switching station is located in an area mapped with Young Alluvial Fan Deposits, undivided, while the paralleling station south of Main Street in the city of Los Angeles is located in Alluvial Fan Deposits. Excavation for these features is too shallow to affect the paleontologically sensitive sediments of the Alluvial Fan Deposits or the paleontologically sensitive deposits of the Young Alluvial Fan Deposits, undivided.

Installation of the positive train control (PTC) infrastructure would involve excavation to approximately 6 to 10 feet along the alignment for the fiber-optic lines and excavation to approximately 30 to 40 feet at intervals of approximately 2 to 3 miles for the communications towers. Depending on which side of the alignment the PTC fiber-optic lines are located, the only geologic unit sensitive to paleontological resources that may be affected is the Puente Formation. Excavation activities for PTC communications towers would affect several paleontologically sensitive geologic units, including the Alluvial Fan Deposits below a depth of 10 feet and the Young Alluvial Fan Deposits, undivided, below a depth of 10 feet. Depending on where the towers are located, excavation activities for the PTC communications towers may also potentially affect the paleontologically sensitive Puente Formation.

Current plans indicate that ground disturbance for the early action project at the Downtown Burbank Metrolink Station would involve excavation to a depth of approximately 5 feet for the trackwork and the parking areas; however, excavation for the pedestrian bridges is expected to range from approximately 8 to 15 feet. The Downtown Burbank Metrolink Station is located in an area mapped with Artificial Fill and Young Alluvial Fan Deposits, undivided. As such, excavation for the trackwork and parking areas would be too shallow to affect the paleontologically sensitive sediments of the Young Alluvial Fan Deposits, undivided. Only construction of the pedestrian bridges would extend deep enough to reach paleontologically sensitive sediments in the Young Alluvial Fan Deposits, undivided.

Ground disturbance associated with the early action project grade separations at Sonora Avenue, Grandview Avenue, Flower Street, Goodwin Avenue, and Main Street would involve traditional excavation to depths of less than approximately 30 feet. The footings for the pedestrian overcrossing at Chevy Chase Drive would extend to depths of approximately 50 to 60 feet. These grade separations are located in areas mapped with Alluvial Fan Deposits and Young Alluvial Fan Deposits, undivided. Excavation for these features could affect the paleontologically sensitive sediments of the Alluvial Fan Deposits or the paleontologically sensitive deposits of the Young Alluvial Fan Deposits, undivided.

Implementation of GEO-IAMF#11 (engage a qualified paleontological resource specialist), GEO-IAMF#12 (perform final design review and triggers evaluation), GEO-IAMF#13 (prepare and implement a PRMMP), GEO-IAMF#14 (provide a Worker Environmental Awareness Program), and GEO-IAMF#15 (halt construction, evaluate, and treat if paleontological resources are found) would minimize any potential direct impacts on paleontological resources by establishing procedures to monitor and halt construction if paleontological resources are found. These IAMFs reduce impacts on paleontological resources include engaging a PRS to direct monitoring during construction activities in paleontologically sensitive sediments. The PRS would provide Worker Environmental Awareness Program training for project personnel; prepare and implement a PRMMP 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; and halt construction when paleontological resources are found.

CEQA Conclusion

Implementation of GEO-IAMF#11 (engage a qualified paleontological resource specialist), GEO-IAMF#12 (perform final design review and triggers evaluation), GEO-IAMF#13 (prepare and implement a PRMMP), GEO-IAMF#14 (provide a Worker Environmental Awareness Program), and GEO-IAMF#15 (halt construction, evaluate, and treat if paleontological resources are found) would minimize any potential direct impacts on paleontological resources by establishing procedures to monitor and halt construction if paleontological resources are found. These IAMFs reduce impacts on paleontological resources include engaging a PRS to direct monitoring during construction activities in paleontologically sensitive sediments. The PRS provides Worker Environmental Awareness Program training for project personnel; prepares and implements a PRMMP 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; and halts construction when paleontological resources are found.

With implementation of the above-stated IAMFs during construction, the HSR Build Alternative would not directly or indirectly destroy a unique paleontological resource or site. Therefore, the impact of the HSR Build Alternative to paleontological resources under CEQA would be less than significant, and no mitigation is required.

Operations Impacts

Operation of the HSR Build Alternative would include inspection and maintenance along the track and railroad right-of-way, as well as on the structures, fencing, power system, train control, electric interconnection facilities, and communications systems. Chapter 2, Alternatives, more fully describes operation and maintenance. An analysis of potential operational-related impacts is provided below.

Geology, Soils, and Seismicity

Impact GSSPR#14: Surface Fault Rupture during Operation

Similar to what was stated above for Impact GSSPR#1, operation of the HSR Build Alternative would not cause or accelerate the potential for surface fault rupture. Therefore, the project would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction from surface fault rupture during operation beyond what they currently experience. However, the project design includes several IAMFs to minimize the effects on people and structures should a surface fault rupture occur. The potential effects of surface fault rupture during operation include collapse of bridges that support the rails or at-grade damage to the rails that would result in train derailment. Train derailment could also cause secondary effects, such as automobile accidents or the interruption of emergency vehicle traffic where the alignment parallels or crosses streets and highways. GEO-IAMF#6 (ground rupture early warning system) would include the installation of early warning systems and routine maintenance on this section of the HSR system. GEO-IAMF#8 (suspension of operations during an earthquake) would include continuous monitoring and immediate shutdown in the event of an earthquake on any of the faults described above to allow confirmation of acceptable conditions before service would resume on this section of the HSR system.

CEQA Conclusion

As discussed above, GEO-IAMF#6 (ground rupture early warning system) would include the installation of early warning systems and routine maintenance on this section of the HSR system, while GEO-IAMF#8 (suspension of operations during an earthquake) would include continuous monitoring and immediate shutdown in the event of an earthquake to allow confirmation of acceptable conditions before service would resume on this section of the HSR system. Operation of the HSR Build Alternative would not directly or indirectly cause the potential risk of loss of life, injuries, or destruction as a result of surface fault rupture beyond what people are exposed to in the area's current environment. As such, there would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#15: Seismic Ground Shaking during Operation

Similar to what was stated above for Impact GSSPR#2, the project would not cause or accelerate the potential for seismic ground shaking. Therefore, the project would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of seismic ground shaking during operation.

The project includes IAMFs to minimize the effects on people and structures should seismic ground shaking occur during operation. For GEO-IAMF#6, a technical memorandum would be prepared documenting how the project design incorporates the installation of early warning systems triggered by strong ground motion associated with ground rupture. Standard earthquake safety measures would be implemented to protect construction workers and other individuals living and working in the vicinity of the HSR Build Alternative. GEO-IAMF#7 would require preparation of a technical memorandum documenting how all HSR components were evaluated and designed for large seismic ground shaking. GEO IAMF#8 would include installation of a network of instruments to provide ground motion data that would be used with the HSR instrumentation and controls system to temporarily shut down the HSR operation in the event of an earthquake. In addition, train derailment containment devices would be installed in sections across hazardous fault zones as a track safety precaution.

CEQA Conclusion

As discussed above, GEO-IAMF#6 would include the installation of early warning systems, triggered by strong ground shaking and monitoring of known nearly active faults along the HSR alignment. GEO-IAMF#7 would require preparation of a technical memorandum documenting how all HSR components were evaluated and designed for large seismic ground shaking. GEO-IAMF#8 would include installation of a network of instruments to provide ground motion data that would be used with the HSR instrumentation and controls system to temporarily shut down HSR system operation in the event of an earthquake. In addition, train derailment containment devices would be installed in sections across hazardous fault zones as a track safety precaution. Operation of the HSR Build Alternative would not cause or accelerate the potential for seismic ground shaking. Moreover, implementation of the aforementioned IAMFs would minimize the effects on people and structures should strong seismic ground shaking occur. Therefore, operation of the HSR Build Alternative would not directly or indirectly cause potential risk of loss of life, injuries, or destruction as a result of seismic ground shaking beyond what people are exposed to currently in the resource hazards RSA. There would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#16: Liquefaction and Other Types of Seismically Induced Ground Failure during Operation

Similar to what was stated above for Impact GSSPR#3, the HSR Build Alternative includes IAMFs to minimize the effects on people and structures in the event that liquefaction or other seismically induced ground failures occur. Preparation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design (GEO-IAMF#10) would minimize risks associated with liquefaction and seismically induced slope failure during operation. Detailed slope stability evaluations would be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures. Under GEO-IAMF#2, during operation, slope monitoring would be performed at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading.

CEQA Conclusion

Preparation of a technical memorandum documenting how specific guidelines and standards have been incorporated into facility design and construction (GEO-IAMF#10) would minimize risks associated with liquefaction and seismically induced slope failure during project operations. Detailed slope-stability evaluations would be conducted, and engineering measures such as ground improvement, use of retaining walls, or regrading of slopes would be implemented, as appropriate, to reduce the potential for seismically induced slope failures. In addition, under GEO-IAMF#2, during operation, slope monitoring should be performed at sites identified in the CMP where a potential for long-term instability exists from gravity or seismic loading. As a result of these measures, the HSR Build Alternative would not directly or indirectly cause the potential loss of life, injuries, or destruction as a result of liquefaction or other types of seismically induced ground failure during operation beyond what people are exposed to currently in the resource hazards RSA. There would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#17: Seismically Induced Flooding due to Dam Failure, Seiche, or Tsunami during Operation

As noted in Section 3.9.5.1, due to the distance to the nearest dam (5.9 miles) and nearest ocean (more than 14 miles), the risk of flooding of the HSR Build Alternative from seiche or tsunami is low. Portions of the resource hazards RSA are within the flood inundation zones of Hansen Dam and Eagle Rock Dam, as well as several reservoirs within and near the resource hazards RSA. 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. The risk of exposure to flooding of the HSR Build Alternative as a result of seismically induced 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 hazards RSA.

CEQA Conclusion

As noted in Section 3.9.5.1, the potential for a seismically induced flooding event to affect the HSR Build Alternative as a result of dam failure, seiche, or tsunami is low. The HSR Build Alternative would not directly or indirectly cause potential risk of loss of life, injuries, or destruction during operation due to seismically induced dam failure, seiche, or tsunami beyond what people currently experience in the resource hazards RSA. Therefore, there would be a less than significant impact under CEQA. No mitigation is required.

Impact GSSPR#18: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Operation

While portions of the resource hazards RSA at the south end near the I-5/SR 110 interchange (near Elysian Park), in the central area aligning with Griffith Park, and at the north end northeast of Hollywood Burbank Airport are within areas designated by CGS as potential landslide hazard zones, there are no pre-existing landslides within or adjacent to the project footprint. The consequences of slope failure during operation of the HSR Build Alternative would be either loss of bearing support to the track facilities or increased load on structures that are in the path of the slope failure. The former represents the higher risk because of the flat topography along the HSR Build Alternative. Loss of bearing support would affect at-grade and retained-fill segments more than retained cuts and elevated structures, such as grade separations or railroad bridges, supported on deep foundations. These failures could endanger people and on- and off-site structures if the HSR track were damaged.

The HSR Build Alternative's design addresses slope stability by incorporating standard International Building Code and other engineering standards and criteria. Detailed slope stability evaluations would be conducted and impact avoidance measures, such as structural solutions (e.g., tie backs, soil nails, or retaining walls) or geotechnical solutions (e.g., ground improvement or regrading of slopes), would be implemented as appropriate to reduce the potential for future slumps and slope failures. Structural solutions would physically hold cuts in slopes in place with walls or other physical structures, while geotechnical solutions would improve the soils to increase stability or reduce slopes to eliminate slope failure. The sequential excavation method (SEM) that would be employed to construct underneath Hollywood Burbank Airport would require the use of stiff pre-support, such as a grouted pipe canopy, and face support, such as face dowels and shotcrete, multiple drifts and short round lengths, and early installation of the center wall. These measures are to control ground loss ahead of the face and face stability. In the case of elevated structures, such as grade separations and railroad bridges, the location of the foundation would occur during the design stages to avoid the area of slope failure. GEO-IAMF#2, which requires slope monitoring, would ensure that the Authority incorporates slope monitoring by a Registered Engineering Geologist into the construction procedures. Therefore, with implementation of this IAMF, the project would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of slope failure hazards associated with cut and fill during operation.

CEQA Conclusion

GEO-IAMF#2, which requires slope monitoring, would ensure that the HSR Build Alternative would not directly or indirectly cause potential loss of life, injuries, or destruction as a result of seismically induced slope failure hazards associated with landslides or cut-and-fill slopes during operation. The impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#19: Soil Erosion during Operation

Operation activities such as maintenance, would not involve ground disturbance and, therefore, would not result in soil erosion. Moreover, because the HSR Build Alternative is an urban area and topsoil is not present, the HSR Build Alternative would not result in a loss of topsoil.

CEQA Conclusion

As noted above, soil erosion impacts would not occur as a result of maintenance activities during operation. Because this is an urban area and topsoil is not present, the HSR Build Alternative would not result in a loss of topsoil. Therefore, there is no impact under CEQA, and no mitigation is required.

Impact GSSPR#20: Unstable or Collapsible Soils during Operation

As described above for Impact GSSPR#7, the potential effects from collapsible soils would be addressed during construction. Therefore, with implementation of GEO-IAMF#1, the project would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of collapsible soils during operation.

While the project would implement IAMFs during construction to minimize the effects of collapsible soils, the proposed project design would also incorporate design features that consider the short- and long-term effects of unstable soils on the HSR Build Alternative and nearby facilities. Where appropriate, engineered ground improvements, including regrading or groundwater controls, would be implemented to avoid long-term adverse effects from unstable soils. The determination of the appropriate methods would be made before construction during final design. The potential effects of soft or loose soils would be reduced with implementation of these design measures because loose and unstable soils would be improved or foundations would be designed to avoid effects to structures from these conditions.

CEQA Conclusion

The HSR Build Alternative would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of unstable or collapsible soils during operation because implementation of GEO-IAMF#1 would address construction-related ground settlement impacts. There would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#21: Ground Subsidence during Operation

As discussed in Impact GSSPR#8, the HSR Build Alternative includes IAMFs to minimize the effects on people and structures in the event that ground subsidence occurs during construction. The Authority addresses subsidence in its CMP for its design and construction processes (GEO-IAMF#1). GEO-IAMF#9 would include development of a stringent track monitoring program for subsidence monitoring during operations. If monitoring indicates that track tolerances are not met, trains would operate at reduced speeds until track tolerances are restored. It is expected that conventional engineering design (e.g., as-needed reballasting of the tracks) would be implemented at night, outside of the operating hours for the HSR system.

CEQA Conclusion

With implementation of GEO-IAMF#9, the HSR Build Alternative would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of ground subsidence during operation. Therefore, the impact under CEQA would be less than significant, and no mitigation is required.

Impact GSSPR#22: Difficult Excavation Related to Encountering Cobbles or Boulders during Operation

Operational activities associated with the HSR Build Alternative would not involve excavation; therefore, no areas of difficult excavation due to boulders or cobbles would be encountered during operation.

CEQA Conclusion

As described above, no difficult excavation in areas of cobbles or boulders would occur during operation of the HSR Build Alternative. There would be no impact under CEQA, and no mitigation is required.

Impact GSSPR#23: Soil Corrosion and Expansion Hazards during Operation

Soils mapped in the RSA have low to high corrosivity to concrete and moderate to high corrosivity to steel. The potential for corrosion to uncoated steel and concrete represents a substantial risk to the operation of the track system and the track right-of-way for long-term operation. Consequences of corrosion could include eventual loss in the structural capacity of buried steel or concrete components. As such, the HSR Build Alternative would potentially expose people/structures to potential loss of life, injuries, or destruction as a result of corrosive soil conditions over time.

Localized areas underlain by expansive soils are likely to occur within the RSA given the regional geologic circumstances. The effects of expansive soils are more critical to at-grade track segments than to elevated structures, such as grade separations or railroad bridges, on deep foundations, retained fill, or retained cuts. The earth loads associated with at-grade segments of the HSR Build Alternative may not be sufficient to overcome swell potential, and this swell would likely be variable along the alignment, leading to differential movement of the track system. The potential for shrink-swell of expansive soils, if unchecked, represents a risk to structures and the operation of the track system and the track right-of-way for long-term operations, as well as the risk of injury or death of the people on or near the HSR Build Alternative if structures fall or the train derails.

A comprehensive geotechnical/geological investigation program conducted during final design would determine the locations of corrosive and expansive soils, as well as their deformation potential. The project includes IAMFs to minimize the effects on people and structures in the event that corrosive or expansive soils are found during geotechnical investigation, and these soil conditions would have been addressed during construction. Through implementation of the CMP identified in GEO-IAMF#1, the corrosive soils would have been removed, buried structures would have been designed for corrosive conditions, and corrosion-protected materials would have been used in infrastructure. Also through implementation of this CMP, shrink-swell soils would have been treated or removed. By following the design and construction BMPs, standards, and guidelines described in GEO-IAMF#10, areas with corrosive or expansive soils would have been treated appropriately during construction so the effects of corrosive and expansive soils are minimized during operation.

Therefore, the HSR Build Alternative would not increase the potential to expose people or structures to potential loss of life, injuries, or destruction as a result of corrosive or expansive soil conditions beyond existing conditions during operation.

CEQA Conclusion

The potential for corrosion to uncoated steel and concrete, as well as the potential for shrink-swell of expansive soils, represents substantial risks to the operation of the track system and the track right-of-way. However, implementation of GEO-IAMF#1 and GEO-IAMF#10 as part of the project would ensure that buried structures would be designed for corrosive conditions, corrosion-protected materials would be used, and corrosive and expansive soils would be removed or treated as appropriate. Therefore, the HSR Build Alternative would not create substantial direct or indirect risks to life or property as a result of corrosive or expansive soil conditions during operation. There would be a less than significant impact under CEQA, and no mitigation is required.

Impact GSSPR#24: Availability of Mineral Resources during Operation
Operation of the HSR Build Alternative would not reduce the availability of zoned mineral resources or hinder access to existing mining facilities.

CEQA Conclusion
As described above, the availability of mineral resources would not be reduced or hindered by operation of the HSR Build Alternative. There is no impact under CEQA, and no mitigation is required.

Impact GSSPR#25: Potential Exposure to Hazardous Gases during Operation
Upon completion of project construction, the chances of subsurface gases encroaching the project causing significant effects to human health and environment are unlikely. Therefore, operation of the HSR Build Alternative would not increase the risk of potential exposure to hazardous gases. If hazardous gases are encountered during construction, necessary precautions such as gas detection systems, installation of an adequate venting system to prevent accumulation of vapors, gas collection systems at below ground portions of the project would be considered during the operation phase, similar.

CEQA Conclusion
As described above, the chances of exposure to subsurface gas hazards during operation of the HSR Build Alternative are low. Therefore, there would be a less than significant impact under CEQA; no mitigation is required.

Paleontological Resources

Impact GSSPR#26: Geologic Units Sensitive to Paleontological Resources during Operation
Operational activities associated with the HSR Build Alternative and the early action projects would not involve ground disturbance in undisturbed, native geologic units. Therefore, operation of the HSR would not affect geologic units sensitive for paleontological resources.

CEQA Conclusion
As described above, no ground disturbance in undisturbed, native geologic units would occur during operation of the HSR Build Alternative. There would be no impact under CEQA, and no mitigation is required.

3.9.7 Mitigation Measures

NEPA requires federal agencies to identify potentially adverse effects and identify measures to mitigate those effects. CEQA requires that each significant impact of a project be identified and feasible mitigation measures be stated and implemented. Mitigation measures are identified for adverse (NEPA) and significant (CEQA) construction and operations impacts that cannot be avoided or minimized adequately by refining project design or through IAMFs.

3.9.7.1 High-Speed Rail Build Alternative

For the HSR Build Alternative, all construction and operations impacts would be minimized and avoided through the implementation of IAMFs. Therefore, no geology, soils, seismicity, and/or paleontological resources mitigation measures are required.

3.9.7.2 Early Action Projects

As described in Chapter 2, Section 2.5.2.9, early action projects would be completed in collaboration with local and regional agencies, and they include grade separations and improvements at regional passenger rail stations. These early action projects are analyzed in further detail to allow the agencies to adopt the findings and mitigation measures as needed to construct the projects. For the early action projects, all construction and operations impacts would be minimized and avoided through the implementation of IAMFs. Therefore, no geology, soils, seismicity, and/or paleontological resources mitigation measures are applicable to the early action projects.

3.9.8 NEPA Impact Summary

This section summarizes the impacts of the HSR Build Alternative and compares them to the anticipated impacts of the No Project Alternative.

Under the No Project Alternative, recent development trends are anticipated to continue, leading to impacts on and from 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 through adherence to geotechnical and stability regulations and would be designed to avoid or minimize effects.

Geological hazards (e.g., ground subsidence and expansive soils), primary seismic hazards (e.g., seismic ground motion), secondary seismic hazards (e.g., liquefaction and lateral spreading), geological resources (e.g., mineral resources and fossil fuel resources), and paleontological resources have the potential to affect or be affected by construction and/or operation of the HSR Build Alternative. As such, construction and/or operation activities could result in an impact. However, all of these impacts would be effectively avoided or minimized through IAMFs, such as complying with the latest seismic design criteria and halting operations of the HSR system in the event of an earthquake. While the effects from some hazards, such as seismic ground shaking, cannot be completely avoided, the project design and project features would not increase the risk to passengers, workers, or the general public from these hazards. More information regarding the specific impacts and corresponding IAMFs for the HSR Build Alternative are described below:

- During construction of the HSR Build Alternative, changes to vegetation cover from ground-disturbing activities could expose unprotected soils to erosive forces of wind and water. However, the alignment is in an urban area with no agricultural use or farmland, and therefore, no topsoil is present. Implementation of GEO-IAMF#1, GEO-IAMF#10, and HYD-IAMF#3 would be effective in avoiding substantial soil erosion. The HSR Build Alternative's design would include adoption of BMPs, including revegetation and covering areas with geotextiles, along with the use of riprap and check dams. During operation, no additional changes to vegetation cover or ground disturbance would occur. Therefore, operation of the HSR Build Alternative would not exacerbate exposure of unprotected soils to erosion.
- Construction of the HSR Build Alternative would not create or exacerbate existing hazards involving ground subsidence or slope failure associated with landslides that could result in injury to people or damage to property. GEO-IAMF#1 addresses the existing potential for subsidence through design and construction processes implemented prior to and during construction. Hazards associated with cut-and-fill slopes during construction would be addressed through the implementation of GEO-IAMF#10. During operation, GEO-IAMF#2 and GEO-IAMF#9 include effective practices to address the effects of ongoing settlement and subsidence through slope monitoring and subsidence monitoring so that any ground movement can be addressed before it can damage track integrity.
- Although poor soil conditions, including expansive, corrosive, collapsible, or erodible soils may exist within the alignment, construction of the HSR Build Alternative would not aggravate those existing conditions or the hazards posed by those conditions that could result in injury to people or damage to property. A comprehensive geotechnical/geological investigation program would be conducted during final design to determine the locations of poor soil conditions and the appropriate modifications, treatments, and materials would be incorporated into the final design to address those conditions. Implementation of GEO-IAMF#1 and GEO-IAMF#10 during construction would avoid the potential effects on personal

safety of passengers and HSR infrastructure presented by those poor soil conditions, regardless of whether those effects were presented during construction or during operation.

- During construction of the HSR Build Alternative, GEO-IAMF#10 would address risk factors associated with difficult excavation conditions, such as hardpan or the presence of cobbles or boulders. Operation of the HSR Build Alternative would not involve ground disturbance and therefore, would not create or exacerbate difficult excavation conditions or any hazards posed by difficult excavation.
- Construction of the HSR Build Alternative would not increase the risk of exposing people or structures to potential effects of seismic hazards, including surface fault rupture, liquefaction, dam failure, or seismic-related ground motion, beyond the existing level. Implementation of GEO-IAMF#1, GEO-IAMF#6, GEO-IAMF#7, and GEO-IAMF#10 prior to and during construction would reduce the potential effects from seismic hazards. During operation, the implementation of GEO-IAMF#2, GEO-IAMF#6, and GEO-IAMF#8 would minimize the potential effects of surface fault rupture, seismically induced ground shaking, displacements, and liquefaction on HSR operations.
- Construction of the HSR Build Alternative may temporarily reduce the availability to access zoned mineral resources, as well as access to existing mining facilities near the alignment. However, through implementation of GEO-IAMF#1, prior to construction, the contractor shall prepare a CMP addressing how construction would minimize or avoid impacting access to locations of existing or future mines. In addition, per SS-IAMF#4, the contractor would evaluate historic and/or abandoned mines to determine if any clean up or stabilization of mine tailings is required. Operation of the HSR Build Alternative would not affect the availability of zoned mineral resources or hinder access to existing mining facilities near the alignment.
- Construction of the HSR Build Alternative, particularly of the below-grade components at the northern end and in the oil fields in the southern portion of the resource hazards RSA, could potentially encounter subsurface gases, thus posing a safety risk to workers and others in the vicinity. Implementation of GEO-IAMF#3 and SS-IAMF#4 would avoid the potential effects related to safety and loss of productivity during construction. With the implementation of standard design and construction protocols (see GEO-IAMF#4), potential issues related to the availability of access to zoned mineral resources during construction of the HSR Build Alternative would not increase beyond those that currently exist. Operation of the HSR Build Alternative would not increase the risk of exposure to subsurface hazardous gases, nor would it affect the availability of zoned mineral resources.
- Construction of the HSR Build Alternative would involve ground-disturbing activities that would have the potential to affect geologic units with a high sensitivity for paleontological resources. GEO-IAMF#11, GEO-IAMF#12, GEO-IAMF#13, GEO-IAMF#14, and GEO-IAMF#15 include provisions for avoiding the loss of paleontological resources in areas of high paleontological sensitivity. Operational activities associated with the HSR Build Alternative would not involve ground disturbance in geologic units sensitive to paleontological resources. Therefore, operation would not affect significant paleontological resources.

3.9.9 CEQA Significance Conclusions

Table 3.9-14 provides a summary of the CEQA determination of significance for all construction and operations impacts discussed in Section 3.9.6.3.

Table 3.9-14 Summary of CEQA Significance Conclusions and Mitigation Measures for Geology, Soils, Seismicity, and Paleontological Resources

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Construction			
Impact GSSPR#1: Surface Fault Rupture during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#2: Seismic Ground Shaking during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#3: Liquefaction and Other Types of Seismically Induced Ground Failure during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#4: Seismically Induced Flooding Due to Dam Failure, Seiche, and Tsunami during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#5: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#6: Soil Erosion during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#7: Unstable or Collapsible Soils during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#8: Ground Subsidence during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#9: Difficult Excavation Related to Encountering Cobbles or Boulders during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#10: Soil Corrosion and Expansion during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#11: Availability of Mineral Resources during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#12: Potential Exposure to Hazardous Gases during Construction	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#13: Geologic Units Sensitive to Paleontological Resources during Construction	Less than Significant	No mitigation measures are required	N/A
Operations			
Impact GSSPR#14: Surface Fault Rupture to People and Property during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#15: Seismic Ground Shaking to People and Property during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#16: Liquefaction and Other Types of Seismically Induced Ground Failure during Operation	Less than Significant	No mitigation measures are required	N/A

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Impact GSSPR#17: Seismically Induced Flooding Due to Dam Failure, Seiche, and Tsunami during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#18: Seismically Induced Slope Failure Hazards Associated with Landslides and Cut-and-Fill Slopes during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#19: Soil Erosion during Operation	No Impact	No mitigation measures are required	N/A
Impact GSSPR#20: Unstable or Collapsible Soils during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#21: Ground Subsidence during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#22: Difficult Excavation Related to Encountering Cobbles or Boulders during Operation	No Impact	No mitigation measures are required	N/A
Impact GSSPR#23: Soil Corrosion and Expansion Hazards during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#24: Availability of Mineral Resources during Operation	No Impact	No mitigation measures are required	N/A
Impact GSSPR#25: Potential Exposure to Hazardous Gases during Operation	Less than Significant	No mitigation measures are required	N/A
Impact GSSPR#26: Geologic Units Sensitive to Paleontological Resources during Operation	No Impact	No mitigation measures are required	N/A

HSR = high-speed rail
N/A = Not applicable