3.9 Geology, Soils, Seismicity, and Paleontological Resources

This section describes the regulatory setting and affected environment related to geology, soils, seismicity, and paleontological resources (GSSPR) for the Bakersfield to Palmdale Project Section (B-P) of the California High-Speed Rail (HSR) System. This section includes analysis for the following components associated with the B-P Section:

- Bakersfield to Palmdale Build Alternatives 1, 2, 3, and 5 (B-P Build Alternatives)
- The César E. Chávez National Monument Design Option (CCNM Design Option)
- The Refined César E. Chávez National Monument Design Option (Refined CCNM Design Option)
- The portion of the Fresno to Bakersfield Locally Generated Alternative (F-B LGA) from the intersection of 34th Street and L Street to Oswell Street[1]
- The Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility (LMF/MOWF/MOIS facilities) in the B-P Section

Geology, Soils, and Seismicity

Geology, soils, and seismicity are factors that often determine the design criteria for the development of passenger rail improvements, particularly those that involve grade separation structures and tunneling. This section summarizes the geologic materials, faults, seismic characteristics, and other subsurface conditions of the resource study area.

This section also evaluates the presence of economically valuable geology, soil, and paleontological resources and the likelihood of their loss from construction of the project.

The impact analysis addresses the potential effects of these resources on the HSR project design, construction, and operation, as well as the effect the HSR project would have on existing GSSPR. The analysis considers a review and assessment of published maps, professional publications, and reports of the project vicinity, as well as consultation with subject matter experts and field surveys.

Summary of Results

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would be in one of the most seismically active areas in the U.S., crossing major active fault zones; therefore, geologic-related risks are of particular concern in this region. Geologic risks, as well as potential operations impacts for the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities are considered during design and construction, whereas paleontological resources are generally restricted to the construction phase of project implementation. Where hazards exist, the project would use well-proven methods to address these hazards.

Geologic features and seismological conditions in the resource study area (RSA) would affect the engineering design for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. The conditions and factors expected to present the greatest challenges to construction are nearby earthquake faults, seismic shaking from nearby faults, unstable soils, soil settlement, soil erosion, difficult excavation, exposure to hazardous gas and hazardous minerals, and abandoned mines. With appropriate mitigation, none of the geologic or soil conditions preclude completing the project. Implementation of the B-P Build Alternatives (including the portion of the F-B LGA from the intersection of 34th Street and L Street

[1] The portion of the Fresno to Bakersfield Locally Generated Alternative (F-B LGA) alignment from the intersection of 34th Street and L Street to Oswell Street is analyzed and considered as part of the HSR Bakersfield to Palmdale Project Section under all of the Build Alternatives. The *Fresno to Bakersfield Section Final Supplemental Environmental Impact Report* (EIR) (Authority 2018b) approved the F-B LGA alignment from the City of Shafter through the Bakersfield F Street Station; however, the portion of the F-B LGA alignment from the intersection of 34th Street and L Street to Oswell Street has not been approved. As such, the approval of this portion of the alignment will occur through approval of the Bakersfield to Palmdale Project Section.

to Oswell Street) and the LMF/MOWF/MOIS facilities would not preclude any mineral extraction opportunities, and no tunneling would take place in active fault zones. Projects associated with the No Project Alternative would face the same geotechnical challenges as the B-P Build Alternatives, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. Direct impacts on paleontological resources are the result of destruction or damage by breakage and crushing, typically in construction-related activities, and the loss of information associated with these resources. In areas containing paleontologically sensitive geologic units, construction of any of the B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street and LMF/MOWF/MOIS facilities could affect an unknown quantity of surface and subsurface fossils. Construction monitoring by a qualified paleontologist and procedures for identification, collection, and preservation (should fossils be uncovered during construction activities) would assist in avoiding or minimizing these impacts. The impacts of the No Project Alternative would be minimal and comparable to those predicted for the B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities.

During construction, the project would incorporate appropriate construction best management practices (BMP), standard engineering design measures, and impact avoidance and minimization features (IAMF) to address risks associated with geology, soils, and seismicity, as well as appropriate IAMFs to address paleontological resources. The project will also use IAMFs to address operational hazards and include adherence to guidelines issued by the American Association of State Highway and Transportation Officials, the American Railway Engineers and Maintenance-of-Way Association, the California Department of Transportation (Caltrans), the Federal Highway Administration, and the International Building Code (IBC). The design measures mentioned above would minimize the impacts on GSSPR, and would therefore have a less than significant impact under the California Environmental Quality Act (CEQA).

3.9.1 Introduction

This section identifies geologic, soil, and seismic conditions, as well as paleontological resources that could affect or be affected by the Bakersfield to Palmdale Project Section of the California HSR System. This section also describes the regulatory setting, affected environment, impacts, and proposed IAMFs associated with the GSSPR of the project vicinity. The discussion of impacts presented in this section considers the consequences of the Bakersfield to Palmdale Project Section on GSSPR, as well as how geology, soils, and seismicity would affect the alignment. The *Bakersfield to Palmdale Project Section Geology, Soils, and Seismicity Technical Report* (California High-Speed Rail Authority [Authority] 2016c) provides detailed geologic, soils, and seismic information. In addition, the *Bakersfield to Palmdale Project Section Geologic and Seismic Hazards Report* (Authority 2016a) presents a more detailed discussion of geotechnical conditions, and the *Bakersfield to Palmdale Project Section Paleontological Resources Technical Report* (Authority 2019) presents a detailed paleontological analysis. For information on how to access and review technical reports, please refer to the Authority's website at www.hsr.ca.gov.

This section addresses distinct sets of potential consequences as they relate to two different technical disciplines—geology, soils, and seismicity conditions and paleontological resources. Each of these technical disciplines is supported by its own technical report, because their RSAs, baseline conditions, and assessment methodologies are distinct and separate. This section includes subheadings to differentiate between the disciplines.

The 2005 *Statewide Program Environmental Impact Report/Environmental Impact Statement* (EIR/EIS) concluded that in the Bakersfield to Palmdale Project Section area, the project would have a high potential for impacts related to seismic hazards and active fault crossings due to the prevailing geology, soils, and seismicity conditions (Authority and Federal Railroad Administration [FRA] 2005). The project alignment would have medium potential for impacts related to difficult excavation and oil and gas fields, and low potential for impacts related to slope instability and mineral resources. With regard to paleontological resources, the 2005 Statewide Program EIR/EIS concluded that the project would have the potential to cause impacts, which would be reduced upon implementation of avoidance and mitigation strategies.

Project design and operation include design standards that minimize risk and address potential hazards. These standards were selected to reduce potential impacts from geologic hazards (subsidence, oil and gas fields, mineral resources, slope failure, and difficult excavation), seismic hazards (major fault crossings and seismic ground shaking), and soil-related hazards (unstable soils, erosion, corrosivity, and soil expansion). The project incorporates design standards from the American Association of State Highway and Transportation Officials, the American Railway Engineers and Maintenance-of-Way Association, Caltrans, and the California Building Standards Code (which, per Title 24 of the California Code of Regulations, is based on the 2009 IBC) to address the identified geologic and soil conditions.

Geologic, soils, and seismic hazards that could affect the design, construction, and operation of the project include unstable slopes, soil settlement, accelerated erosion, expansive and corrosive soil properties, surface fault rupture, seismic ground shaking, and earthquake-induced ground liquefaction and slope destabilization. This analysis omits the following discussions because they do not present a risk in the Bakersfield to Palmdale Project Section:

- **Volcanic Eruption—**Volcanic ash can fall from a volcanic eruption of the Long Valley Caldera; however, the southwestern edge of the Long Valley Caldera is approximately 155 miles from the closest point on the Bakersfield to Palmdale Project Section. The probability of an eruption occurring in any given year is very low (less than 1 percent per year), according to the U.S. Geological Survey (USGS), making the risk of ash fall very low.
- **Seiches and Tsunami Flooding—**No oceans, bays, or other bodies of water sufficient to result in a damaging seiche or tsunami occur near the project alignment.

Seiche

Seismic seiches are waves in closed bodies of water, such as reservoirs, ponds, and lakes, caused by earthquake shaking (USGS 2017b).

Certain geologic and soil conditions depend on proximity to streams and rivers; Section 3.8, Hydrology and Water Resources, discusses these conditions. Section 3.11, Safety and Security, addresses the earthquake safety of the HSR system.

3.9.2 Laws, Regulations, and Orders

The analysis below presents federal, state, and local laws, regulations, orders, or plans germane to GSSPR that the project would affect. Section 3.1, Introduction, describes the general National Environmental Policy Act (NEPA) and CEQA requirements for assessment and disclosure of environmental impacts; therefore, these requirements are not restated in this section. Use of these guidelines and standards would help avoid or reduce potential risks from geologic hazards and adverse project impacts on geology, soils, and seismicity.

3.9.2.1 Federal

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

The FRA's *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 energy and mineral resources.

American Antiquities Act of 1906 (16 U.S. Code § 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 Code of Federal Regulations Part 3) specifically mentions paleontological resources. Many federal agencies, however, have interpreted objects of antiquity as including fossils. Therefore, projects involving federal lands require permits for both paleontological resource evaluation and mitigation efforts. Consequently, the American Antiquities Act represents an early cornerstone for efforts to protect the nation's paleontological resources.

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

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

Federal Land Policy and Management Act of 1976 (43 U.S. Code § 1701–1782)

The Federal Land Policy and Management Act authorizes inventories of paleontological resources on federal land managed by the Bureau of Land Management, which now issues permits for collecting paleontological resources.

3.9.2.2 State

Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources [Cal. Public Res.] Code § 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 of human occupancy across the trace of active faults. The act also requires site-specific studies by licensed professionals for some types of proposed construction within delineated earthquake fault zones.

Seismic Hazards Mapping Act (Cal. Public Res. Code §§ 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 (Cal. Public Res. Code § 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 (Cal. Public Res. 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 (Cal. Public Res. Code §§ 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 (Cal. Public Res. Code, § 21000 et seq.) and CEQA Guidelines Protection for Paleontological Resources

The 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 Cal. Public Res. Code also protects paleontological resources in specific contexts. In particular, Cal. Public Res. Code § 5097.5 prohibits “knowing and willful” excavation, removal, destruction, injury, and defacement of any 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 and/or imprisonment (Cal. Public Res. Code § 5097.5(c)), and persons convicted of such a violation may also be required to provide restitution (Cal. Public Res. Code § 5097.5(d)(1)). Additionally, Cal. Public Res. Code § 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, §§ 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” but also assign 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

Appendix 2-H provides a list of the plans, policies, and ordinances adopted by the cities and counties in the Bakersfield to Palmdale Project Section. State planning and zoning law (California Government Code Section 65302(a)) establishes the requirements for the land use element of general plans prepared by counties and cities. These requirements guide decision-makers, planners, and the general public as to the ultimate pattern of development within the unincorporated areas of the county and within the city. Section § 65302(g) requires general plans to include a safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; and other geologic hazards known to the legislative body. Both Kern and Los Angeles Counties, as well as the Cities of Bakersfield, Tehachapi, Palmdale, and Lancaster, have a health and safety element in their general plans. In addition, the county and city general plans contain conservation elements, which call for the protection of natural resources, including mineral resources.

In general, city and county ordinances require soils engineering and geologic/seismic analysis of developments, including public infrastructure, in areas prone to geologic or seismic hazards, and enforce the California Building Standards Code. The Cities of Bakersfield, Tehachapi, Lancaster, and Palmdale also have local grading ordinances that essentially require all earthwork construction to be done in conformance with the California Building Standards Code and require grading work to follow BMPs.

3.9.3 Regional and Local Policy Analysis

The Authority and FRA have consulted extensively with local government officials and local public agency staff during the planning and design of the HSR project, including during development of the range of alternatives for study.

Because the HSR project is an undertaking of the Authority in its capacity as state agency and representative of a federal agency, it is not required to be consistent with local plans. Council on

Environmental Quality and FRA regulations, however, require the discussion of any inconsistency or conflict of a proposed action with regional or local plans and laws. Where inconsistencies or conflicts exist, the Council on Environmental Quality and the Authority require a description of the extent of reconciliation and the reason for proceeding if full reconciliation is not feasible (Code of Federal Regulations Title 40, Part 1506.2(d) and *Federal Register* Volume 64, Page 28545, 14(n)(15)). The CEQA Guidelines also require that an EIR discuss the inconsistencies between the proposed project and applicable general plans, specific plans, and regional plans (CEQA Guidelines §15125(d)).

Table 3.9-1 provides a summary of the project's consistency with the local jurisdictions and planning documents relevant to this section of the HSR project. Please refer to Appendix 2-H for a detailed listing and analysis of the HSR project's consistency with local planning documents.

Table 3.9-1 Regional and Local Policy Consistency Analysis Summary

Policy/Goal/Objective	Segments	Alternatives	Consistency
Kern County General Plan (2009): Land Use, Open Space, and Conservation Element, Safety Element	Unincorporated Kern County	All B-P Build Alternatives	Consistent
Kern County General Plan (2009): Safety Element	Unincorporated Kern County	All B-P Build Alternatives	Consistent
Metropolitan Bakersfield General Plan (2007): Conservation	City of Bakersfield/ Community of Edison	All B-P Build Alternatives and the F Street Station	Consistent
Metropolitan Bakersfield General Plan (2007): Safety Element	City of Bakersfield/ Community of Edison	All B-P Build Alternatives and the F Street Station	Consistent
Los Angeles County General Plan (2015): Conservation and Natural Resources Element	Unincorporated Los Angeles County	All B-P Build Alternatives	Consistent
Los Angeles County General Plan (2015): Safety Element	Unincorporated Los Angeles County	All B-P Build Alternatives	Consistent
Tehachapi General Plan (2012): Natural Resources Element, Soil and Minerals Section	City of Tehachapi	All B-P Build Alternatives	Consistent
Tehachapi General Plan (2012): Community Safety Element	City of Tehachapi	All B-P Build Alternatives	Consistent
Lancaster General Plan 2030 (2009): Plan for the Natural Environment	City of Lancaster	All B-P Build Alternatives and Lancaster North B MOWF	Consistent
Lancaster General Plan 2030 (2009): Plan for Public Health and Safety	City of Lancaster	All B-P Build Alternatives and Lancaster North B MOWF	Consistent
Palmdale General Plan (1993): Land Use Element	City of Palmdale	All B-P Build Alternatives and the Avenue M LMF Zone and Palmdale Station	Consistent
Palmdale General Plan (1993): Environmental Resources Element	City of Palmdale	All B-P Build Alternatives and the Avenue M LMF Zone and Palmdale Station	Consistent

Policy/Goal/Objective	Segments	Alternatives	Consistency
Palmdale General Plan (1993): Safety Element	City of Palmdale	All B-P Build Alternatives and the Avenue M LMF Zone and Palmdale Station	Consistent

B-P = Bakersfield to Palmdale Project Section MOWF = maintenance-of-way facility
LMF = light maintenance facility

3.9.4 Methods for Evaluating Impacts

This section describes the RSA and methods for evaluating GSSPR impacts. The methodology used to describe the affected environment and evaluate the potential environmental impacts of the project on GSSPR involved a review and assessment of published maps, professional publications, and reports pertaining to the geology, soils, and seismicity of the project vicinity. The information included USGS topographic maps; USGS and California Geological Survey (CGS) geologic and landslide maps; U.S. Department of Agriculture, Natural Resources Conservation Service soils maps; CGS Seismic Hazard Zone maps; USGS and CGS active fault maps; USGS and CGS groundshaking maps; California Emergency Management Agency dam inundation maps; USGS and State of California mineral commodity producer databases; and online databases for mineral resources, fossil fuels, and geothermal resources published by the DOGGR. The *Bakersfield to Palmdale Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2016a) provides the results of this analysis in detail. The *Bakersfield to Palmdale Project Section Paleontological Resources Technical Report* (Authority 2019) details the paleontological resources evaluation and analysis.

3.9.4.1 Study Area for Analysis

The RSA is the area in which all environmental investigations specific to GSSPR are conducted to determine the resource characteristics and potential impacts of the project section. The boundaries of the RSA for all resource topics included in GSSPR extend beyond the project footprint and also extend into the subsurface beneath the project alignment. The concept of the RSA is applied slightly differently for geology, soils, and seismicity impacts than for paleontological resources impacts. The sections below explain the basis for defining the two types of GSSPR RSAs and the differences between them.

For this discussion, the Bakersfield to Palmdale Project Section consists of three subsections based on geomorphology. These subsections have the following definitions:

- **San Joaquin Valley Subsection**—This subsection begins in Bakersfield at the F Street Station. It continues southeast through the valley, briefly running parallel to State Route (SR) 58 to Bealville Road, for a distance of approximately 22 miles.
- **Tehachapi Mountains Subsection**—This subsection begins at Bealville Road south of Bakersfield. It continues southeast through the Tehachapi Mountains, generally following SR 58 through Keene, then crossing SR 58 through the City of Tehachapi to the intersection of Tehachapi Willow Springs Road/110th Street W, for a distance of approximately 25 miles.
- **Antelope Valley Subsection**—This subsection begins at the foot of the Tehachapi Mountains. It continues southeast through the community of Rosamond into northern Los Angeles County, running parallel to the Sierra Highway south through Lancaster, then into Palmdale to the Palmdale Station at the Palmdale Transportation Center, a distance of approximately 30 miles. This subsection also contains 2.4 miles of the RSA near the Palmdale Station, which is part of the Transverse Ranges geomorphic province.

Geology, Soils, and Seismicity Resource Study Area

The potential area of disturbance associated with project construction includes the proposed B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities, as well as the roadway changes necessary to accommodate the project and temporary construction laydown areas.

The RSA for geology, soils, and seismicity is defined as the project footprint plus a 150-foot buffer for all resources and conditions, with the exception of several resources and conditions with larger RSAs:

- Resource hazards, such as soil failures (e.g., adequacy of load-bearing soils), settlement, corrosivity, shrink-swell, erosion, earthquake-induced liquefaction risks, subsidence, and subsurface hazards, have an RSA of the project footprint plus a 2,640-foot (0.5-mile) buffer along the project alignment, with the buffer increasing to 10,560 feet (2 miles) around the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, the LMF/MOWF/MOIS facilities and the station site. These radii also apply to subsurface gas hazards, mineral resources, and oil and natural gas resources.
- The seismicity RSA includes the regional extent of earthquake faults or dam failure inundation areas, identified in terms of distance in miles from the project features.

The RSA encompasses the San Joaquin Valley, Tehachapi Mountains, and Mojave Desert for review of seismicity, faulting, and dam failure inundation. It includes earthquake faults identified within a 62-mile (100-kilometer) radius of the proposed B-P Build Alternatives.

Paleontological Resources Resource Study Area

The RSA for paleontological resources is the project footprint plus a 150-foot horizontal buffer around this footprint. In addition, the overall RSA includes the vertical dimension to the depth that would include all geologic units[2] that project construction or operation may encounter. The depth of the vertical dimension would vary regionally based primarily on project construction techniques and proposed construction activity. Geologic units present at some depth may not be mapped at the surface within the RSA; therefore, regional geologic context provides insight into units that have potential to underlie surface geologic units.

Where ground disturbance extends into the subsurface, as is typical for excavation, grading, tunneling, or foundation drilling, the potential impact would occur as a result of disturbance to paleontologically sensitive geologic units from construction activity.

In addition, the current prevailing professional practice considers geologic units that have produced fossils in the past as being likely do so again. Such units are considered sensitive for paleontological resources, and the level of paleontological sensitivity or paleontological potential applies throughout the (three-dimensional) extent of the unit. By the same token, geologic units that have been well studied and have not produced fossils are generally considered less sensitive throughout the region of the unit. In this context, the evaluation of paleontological potential—and by extension, the potential for impacts on fossil resources—depends not on fossil finds within a certain distance of the project footprint, but rather on fossil finds in the geologic units affected by the project, wherever those units occur.

3.9.4.2 Impact Avoidance and Minimization Features

The Authority has pledged to integrate programmatic IAMFs consistent with the (1) 2005 Statewide Program EIR/EIS, (2) 2008 Bay Area to Central Valley Program EIR/EIS, and (3) 2012 Partially Revised Final Program EIR into the HSR project. The Authority would implement these features during project design and construction, as relevant to the HSR project section, to avoid or reduce impacts.

IAMFs incorporated into the project design and construction would avoid or minimize environmental or community impacts. The discussion below summarizes each IAMF. Appendix 2-E, Impact Avoidance and Minimization Features, provides a detailed description of IAMFs that are included as part of the B-P Build Alternatives design.

[2] This document uses the term “geologic units” to denote formally or informally named rock bodies, following the rules and procedures set forth by the North American Commission on Stratigraphic Nomenclature in its North American Stratigraphic Code (2005).

- **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 (SWRCB) Construction General Permit requiring preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP). The Construction SWPPP would propose best management practices (BMP) to minimize potential short-term increases in sediment transport caused by construction, including erosion control requirements, stormwater management, and channel dewatering for affected stream crossings. These BMPs would include measures to incorporate permeable surfaces into facility design plans where feasible, and how treated stormwater would be retained or detained on site. Other BMPs shall include strategies to manage the amount and quality of overall stormwater runoff. The Construction SWPPP would include measures to address, but are not limited to, the following:
  - Hydromodification management to verify maintenance of pre-project hydrology by emphasizing on-site retention of stormwater runoff using measures such as flow dispersion, infiltration, and evaporation (supplemented by detention where required). Additional flow control measures would be implemented where local regulations or drainage requirements dictate.
  - Implementing practices to minimize the contract of construction materials, equipment, and maintenance supplies with stormwater.
  - Limiting fueling and other activities using hazardous materials to areas distant from surface water, providing drip pans under equipment, and daily checks for vehicle condition.
  - Implementing practices to reduce erosion of exposed soil, including soil stabilization, regular watering for dust control, perimeter siltation fences, and sediment catchment basins.
  - Implementing practices to maintain current water quality, including siltation fencing, wattle barriers, stabilized construction entrances, grass buffer strips, ponding areas, organic mulch layers, inlet protection, storage tanks, and sediment traps to arrest and settle sediment.
  - Where feasible, avoiding areas that may have substantial erosion risk, including areas with erosive soils and steep slopes.
  - Using diversion ditches to intercept surface runoff from off site.
  - Where feasible, limiting construction to dry periods when flows in water bodies are low or absent.
  - Implementing practices to capture and provide proper off-site disposal of concrete wash water, including isolation of runoff from fresh concrete during curing to prevent it from reaching the local drainage system, and possible treatments (e.g., dry ice).
  - Developing and implementing a spill prevention and emergency response plan to handle potential fuel and/or hazardous material spills.

  Implementation of a SWPPP would be performed by the construction Contractor as directed by the Contractor's Qualified SWPPP Practitioner or designee. As part of that responsibility, the effectiveness of construction BMPs must be monitored before, during and after storm events. Records of these inspections and monitoring results are submitted to the local Regional Water Quality Control Board as part of the annual report required by the Statewide Construction General Permit. The reports are available to the public online. The State Water Resources Control Board and the Regional Water Quality Control Board would have the opportunity to review these documents.

- **GEO-IAMF#1 Geologic Hazards:** Prior to Construction, the Contractor shall prepare a Construction Management (CMP) addressing how the Contractor would address geologic constraints and minimize or avoid impacts to geologic hazards during construction. The plan would be submitted to the Authority for review and approval. At a minimum, the plan would address the following geological and geotechnical constraints/resources:

a. Groundwater Withdrawal—Controlling the amount of groundwater withdrawal from the project by re-injecting groundwater at specific locations if necessary, or by using alternate foundation designs to offset the potential for settlement. This control is important for locations with retained cuts in areas where high groundwater exists, and where existing buildings are located near the depressed track section.

b. Unstable Soils—Employing various methods to mitigate for the risk of ground failure from unstable soils. If soft or loose soils are encountered at shallow depths, they can be excavated and replaced with competent soils. To limit the excavation depth, replacement materials can also be strengthened using geosynthetics. Where unsuitable soils are deeper, ground improvement methods, such as stone columns, cement deep-soil-mixing, or jet-grouting, can be used. Alternatively, if sufficient construction time is available, preloading—in combination with prefabricated vertical drains (wicks) and staged construction—can be used to gradually improve the strength of the soil without causing bearing-capacity failures.

c. Subsidence. The Authority addresses subsidence in its design and construction processes. For the initial design, survey monuments were installed to establish datum and set an initial track profile. In the construction phase, the design-build contractors for track bed preparation would conduct topographic surveys for preparation of final design. Because subsidence could have occurred since the original benchmarks (survey monuments) were established, the design-build 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 would be given to overbuild the height of the rail bed in anticipation of future subsidence.

d. Water and Wind Erosion. The Contractor would implement erosion control methods as appropriate from the various erosion control methods documented in the Construction SWPPP (See HYD-IAMF#3), the Caltrans Construction Manuals, other construction technical memoranda (see GEO-IAMF#6), and in coordination with other erosion, sediment, stormwater management and fugitive dust control efforts. Water and wind erosion control methods may include, but are not limited to, use of revegetation, stabilizers, mulches, and biodegradable geotextiles.

e. Soils with Shrink-Swell Potential. In locations where shrink-swell potential is marginally unacceptable, soil additives would be mixed with existing soil to reduce the shrink-swell potential. Construction specifications would be based upon the decision whether to remove or treat the soil. This decision is based on the soils, specific shrink-swell characteristics, the additional costs for treatment versus excavation and replacement, as well as the long-term performance characteristics of the treated soil.

f. Soils with Corrosive Potential. In locations where soils have a potential to be corrosive to steel and concrete, the soils would be removed and buried structures would be designed for corrosive conditions, and corrosion-protected materials would be used in infrastructure.

- **GEO-IAMF#2 Slope Monitoring:** During Operation and Maintenance, the Authority shall incorporate slope monitoring by a Registered Engineering Geologist into the Operation and Maintenance procedures. The procedures shall be implemented at sites identified in the Construction Management Plan (CMP) where a potential for long-term instability exists from gravity or seismic loading including but not limited to at-grade sections where slope failure could result in loss of track support, or where slope failure could result in additional earth loading to foundations supporting elevated structures.

- **GEO-IAMF#3 Gas Monitoring:** Prior to Construction, the Contractor shall prepare a CMP addressing how gas monitoring would be incorporated into construction best management practices. The CMP would be submitted to the Authority for review and approval. Hazards related to potential migration of hazardous gases due to the presence of known oil and gas fields, areas of active or historic landfills, or other subsurface sources can be reduced or eliminated by following strict federal and state Occupational Safety & Health Administration (OSHA/Cal-OSHA) regulatory requirements for excavations, and by consulting with other agencies as appropriate, such as the Department of Conservation (Division of Oil and Gas) and the California Environmental Protection Agency, Department of Toxic Substances Control, regarding known areas of concern.

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

- **GEO-IAMF#4 Historic or Abandoned Mines:** Prior to Construction, the Contractor shall prepare a CMP addressing how historic and abandoned mines would be incorporated into construction BMPs. The CMP would be submitted to the Authority for review and approval. Depending on the properties of an individual mine, mitigations to address historic or abandoned mines could include:

  - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Cleanup. Environmental cleanups at sites that are releasing or threatening to release hazardous substances such as heavy metals from acid mine drainage.
  - Non-CERLA Cleanup. Cleanups of non-hazardous substance-related surface disturbance such as revegetation of disturbed areas, stabilization of mine tailings, reconstruction of stream channels and floodplains.
  - Safety Mitigation. Mitigation of physical safety hazards such as closure of adits and shafts and removal of dangerous structures.

- **GEO-IAMF#5 Hazardous Minerals:** Prior to Construction, the Contractor shall prepare a CMP addressing how the contractor would minimize or avoid impacts related to hazardous minerals (i.e., radon, mercury, and naturally occurring asbestos [NOA]) during construction. The CMP would be submitted to the Authority for review and approval. The CMP shall include appropriate provisions for handling hazardous mineral including, but not limited to, dust control, control of soil erosion and water runoff, and testing and proper disposal of excavated material.

- **GEO-IAMF#6 Ground Rupture Early Warning Systems:** Prior to Construction, the Contractor shall document how the project design incorporates installation of early warning systems, triggered by strong ground motion association with ground rupture. Known nearby active faults would be monitored. Linear monitoring systems, such as time domain reflectometers or similar technology, shall be installed along rail lines in the zone of potential ground rupture. These devices emit electronic information that is processed in a centralized location and would be used to temporarily control trains, thus reducing accidents due to fault creep. Damage to infrastructure from fault creep can be mitigated with routine maintenance, including minor realignment.

- **GEO-IAMF#7 Evaluate and Design for Large Seismic Ground Shaking:** Prior to Construction, the Contractor shall document through preparation of a technical memorandum how all HSR components were evaluated and designed for large seismic ground shaking. Prior to final design, the Contractor would conduct additional seismic studies to establish up-to-date estimation of levels of ground motion. The most current Caltrans seismic design criteria at the time of design would be used in the design of any structures supported in or on the ground. These design procedures and features reduce to the greatest practical extent for potential movements, shear forces, and displacements that result from inertial response of the structure. In critical locations, pendulum base isolators may be used to reduce the levels of inertial forces. New composite materials may also be used to enhance seismic performance.

- **GEO-IAMF#8 Suspension of Operations During an Earthquake:** Prior to Operation and Maintenance activities, the Contractor shall document in a technical memorandum how suspension of operations during or after an earthquake was addressed in project design. Motion-sensing instruments to provide ground motion data and a control system to shut down HSR operations temporarily during or after a potentially damaging earthquake would be incorporated into final design. Monitoring equipment would be installed at select locations where high ground motions could occur. The system would then be inspected for damage due to ground motion and/or ground deformation, and then returned to service when appropriate.
- **GEO-IAMF#9 Subsidence Monitoring:** Prior to Operation and Maintenance, the Authority shall develop a stringent track monitoring program. Once tracks are operational, a remote monitoring program would be implemented to monitor the effects of ongoing subsidence. Track inspection systems would provide early warning of reduced track integrity. HSR train sets would be equipped with autonomous equipment for daily track surveys. This specification would be added to HSR train bid packages. If monitoring indicates that track tolerances are not met, trains would operate at reduced speed until track tolerances are restored. In addition, the contractor responsible for wayside maintenance would be required to implement a stringent program for track maintenance.
- **GEO-IAMF#10 Geology and Soils:** Prior to Construction, the Contractor shall document through issuance of a technical memorandum how the following guidelines and standards have been incorporated into facility design and construction:
  - 2015 American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Bridge Design Specifications and the 2015 AASHTO Guide Specifications for Load and Resistance Factor Seismic Bridge Design, or their most recent versions. These documents provide guidance for characterization of soils, as well as methods to be used in the design of bridge foundations and structures, retaining walls, and buried structures. These design specifications would provide minimum specifications for evaluating the seismic response of the soil and structures.
  - Federal Highway Administration (FHWA) Circulars and Reference Manuals: These documents provide detailed guidance on the characterization of geotechnical conditions at sites, methods for performing foundation design, and recommendations on foundation construction. These guidance documents include methods for designing retaining walls used for retained cuts and retained fills, foundations for elevated structures, and at-grade segments. Some of the documents include guidance on methods of mitigating geologic hazards that are encountered during design.
  - American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual: These guidelines deal with rail systems. Although they cover many of the same general topics as the American Association of State Highway and Transportation Officials manuals, they are more focused on best practices for rail systems. The manual includes principles, data, specifications, plans, and economics pertaining to the engineering, design, and construction of railways.
  - California Building Code: The code is based on 2015 International Building Code (IBC). This code contains general building design and construction requirements relating to fire and life safety, structural safety, and access compliance.
  - International Building Code and American Society of Civil Engineers (ASCE)-7: These codes and standards provide minimum design loads for buildings and other structures. They would be used for the design of the maintenance facilities and stations. Sections in IBC and ASCE-7 provide minimum requirements for geotechnical investigations, levels of

earthquake ground shaking, minimum standards for structural design, and inspection and testing requirements.

- Caltrans Design Standards: Caltrans has specific minimum design and construction standards for all aspects of transportation system design, ranging from geotechnical explorations to construction practices. These amendments provide specific guidance for the design of deep foundations that are used to support elevated structures, for design of mechanically stabilized earth (MSE) walls used for retained fills, and for design of various types of cantilever (e.g., soldier pile, secant pile, and tangent pile) and tie-back walls used for retained cuts.
- Caltrans Construction Manuals: Caltrans has a number of manuals including Field Guide to Construction Dewatering, Caltrans Construction Site BMPs Manual, and Construction Site BMP Field Manual and Troubleshooting Guide. These provide guidance and best management practices for dewatering options and management, erosion control and soil stabilization, non-stormwater management, and waste management at construction sites.
- American Society for Testing and Materials (ASTM): ASTM has developed standards and guidelines for all types of material testing, from soil compaction testing to concrete-strength testing. The ASTM standards also include minimum performance requirements for materials.

- **GEO-IAMF#11 Engage a Qualified Paleontological Resource Specialist:** Prior to the 90% design milestone for each construction package[3] (CP) within the Project Section, the Contractor would retain a Paleontological Resource Specialist (PRS) responsible for:
  - Reviewing the final design for the CP.
  - Developing a detailed Paleontological Resources Monitoring and Mitigation Plan (PRMMP) for the CP.
  - The PRS would be responsible for implementing the PRMMP, including development and delivery of WEAP Training, supervision of Paleontological Resource Monitors (PRMs), evaluation and treatment of finds, if any, and preparation of a final paleontological mitigation report, per the PRMMP and for each CP.

  Retention of PRS staff would occur in a timely manner, in advance of the 90% design milestone for each CP, such that the PRS is on board and can review the 90% design submittal without delay when it becomes available. If feasible, the same PRS would be responsible for all CPs within a given Project Section.

  All PRS staff would meet or exceed the qualifications for a Principal Paleontologist as defined in the Caltrans current *Standard Environmental Reference*, Chapter 8 (Caltrans 2012). Appointment of PRS staff would be subject to review and approval by the Authority.

- **GEO-IAMF#12 Perform Final Design Review and Triggers Evaluation:** For each CP within the Project Section, the responsible PRS would evaluate the 90% design submittal to identify the portions of the CP that would involve work in paleontologically sensitive geologic units (either at the surface or in the subsurface), based on findings of the final Paleontological Resources Technical Report (TR) prepared for the Project Section. Evaluation would consider the location, areal extent, and anticipated depth of ground disturbance, the construction techniques that are planned/proposed, and the geology (i.e., the location of geologic units with high paleontological resources) of the CP and its vicinity. The evaluation and resulting recommendations would be consistent with guidance in the Society of Vertebrate Paleontology (SVP) *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (SVP Impact Mitigation Guidelines Revision

[3] Because of their length and complexity, most HSR Project Sections are expected to be designed and constructed in segments, with separate construction documents (plans and specifications) developed for each segment. Construction package refers to a portion (segment) of a Project Section for which a discrete, stand-alone construction document set will be developed.

Committee 2010), the *SVP Conditions of Receivership for Paleontologic Salvage Collections* (SVP Conformable Impact Mitigation Guidelines Committee 1996), and relevant guidance from Chapter 8 of the current Caltrans *Standard Environmental Reference* (Caltrans 2012).

The purpose of the Final Design Review and Triggers Evaluation would be to develop specific language detailing the location and duration of paleontological monitoring and other requirements for paleontological resources applicable to each CP within the Project Section. Paleontological protection requirements identified through the Final Design Review and Triggers Evaluation would be recorded in a concise technical memorandum ("Final Design Review Requirements for Paleontological Resources Protection") which would then be incorporated in full detail into the PRMMP for each CP. Those portions of the CP requiring paleontological monitoring would also be clearly delineated in the project construction documents for each CP.

- **GEO-IAMF#13 Prepare and Implement Paleontological Resources Monitoring and Mitigation Plan (PRMMP):** Following the Final Design Review and Triggers Evaluation for each CP, the PRS would develop a CP-specific PRMMP. For greater efficiency, PRMMPs may be written such that they cover more than one CP, as long as the specific requirements of the IAMFs are satisfied explicitly and in detail for each CP included.

  The PRMMP for each CP would incorporate the findings of the Design Review and Triggers Evaluation for that CP and would be consistent with the Society of Vertebrate Paleontology (SVP) *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (SVP Impact Mitigation Guidelines Revision Committee 2010), the SVP *Conditions of Receivership for Paleontological Salvage Collections* (SVP Conformable Impact Mitigation Guidelines Committee 1996), and relevant guidance from Chapter 8 of the current Caltrans *Standard Environmental Reference* (Caltrans 2012). As such, the PRMMP would provide for at least the following:

  - Implementation of the PRMMP by qualified personnel, including the following positions:
    - Paleontological Resource Specialist—The PRS will be required to meet or exceed Principal Paleontologist qualifications per Chapter 8 of the current *Caltrans Standard Environmental Reference* (Caltrans 2012). The Supervising Paleontologist may, but not necessarily, be the PRS who prepares the PRMMP.
    - Development of pre-construction and construction-period coordination procedures and communications protocols.
    - Evaluation as to whether a pre-construction survey by qualified personnel is warranted for the CP. In general, pre-construction surveys are beneficial if there is a strong possibility that significant paleontological resources (e.g., concentrations of vertebrate fossils) are exposed at the ground surface and would be destroyed during the initial clearing and grubbing phase of earthwork. Such a determination can usually be made during preparation of the paleontological resources TR.
    - Requirements for paleontological monitoring by qualified of all ground-disturbance activities known to affect, or potentially affect, highly sensitive geologic units and for ground-disturbance activities affecting other geologic units in any areas where the PRS considers it warranted based on the findings of the Paleontological Resources or any pre-construction surveys. In all areas of the CP subject to monitoring, monitoring would initially be conducted full time for all ground-disturbance activities. However, the PRMMP may provide for monitoring frequency in any given location to be reduced once approximately 50% of the ground-disturbance activity in completed locations, if the reduction is appropriate based on the implementing PRS' professional judgment in consideration of actual site conditions.
    - Provisions, if recommended by the PRS for paleontological monitoring of specific construction drilling operations. In general, small diameter (i.e., less than 18 inches) drilling operations or drilling operations using bucket augers tend to pulverize

impacted sediments and any contained fossils and are typically not monitored. The section in the PRMMP addressing monitoring for drilling operations would rely, in part, on the information supplied by the CP design and geotechnical teams, but would also take into consideration of the nature, depth, and location of drilling needed and the anticipated equipment and staging configurations.

- Provisions for the content development and delivery of paleontological resources Worker Environmental Awareness Program (WEAP) training.
- Provisions for in-progress documentation of monitoring (and, if applicable, salvage/recovery operations) via "construction dailies" or a similar approved means.
- Provisions for a "stop work, evaluate, and treat appropriately" response in the event of a known or potential paleontological discovery, including finds in highly sensitive geologic units as well as finds, if any, in geologic units identified as less sensitive or non-sensitive for paleontological resources.
- Provisions for sampling and recovery of unearthed fossils consistent with SVP *Standard Procedures* (SVP Impact Mitigation Guidelines Revision Committee 2010) and the SVP *Conditions of Receivership* (SVP Conformable Impact Mitigation Guidelines Committee 1996). Recovery procedures would provide for recovery of both macrofossils and microfossils.
- Provisions for acquiring a repository agreement from an approved regional repository for the curation, care, and storage of recovered materials, consistent with the SVP *Conditions of Receivership* (SVP Conformable Impact Mitigation Guidelines Committee 1996). If more than one repository institution is designated, separate repository agreements must be provided.
- Provisions for preparation of a final monitoring and mitigation report that meets the requirements of the Caltrans *Standard Environmental Reference* Chapter 8 provisions for the Paleontological Monitoring Report and Paleontological Stewardship Summary (Caltrans 2012).
- Provisions for the preparation, identification, and analysis and curation of fossil specimens and data recovered, consistent with the SVP *Conditions of Receivership* (SVP Conformable Impact Mitigation Guidelines Committee 1996) and any specific requirements of the designated repository institution(s).

- **GEO-IAMF#14 Providing WEAP Training for Paleontological Resources:** Prior to groundbreaking for each CP within the Project Section, the Contractor would provide paleontological resources WEAP training delivered by the PRS. All management, supervisory personnel, and construction workers involved with ground-disturbing activities would be required to take this training before beginning work on the project. Refresher training would also be made available to management and supervisory personnel and workers as needed, based on the judgment of the PRS. At a minimum, paleontological resources WEAP training would include information on:

  - The coordination between construction staff and paleontological staff
  - The construction and paleontological staff roles and responsibilities in implementing the PRMMP
  - The possibility of encountering fossils during construction
  - The types of fossils that may be seen and how to recognize them
  - The proper procedures in the event fossils are encountered, including the requirement to halt work in the vicinity of the find and procedures for notifying responsible parties in the event of a find.

  Training materials and formats may include, but are not necessarily limited to, in-person training, prerecorded videos, posters, and informational brochures that provide contacts and summarize procedures in the event paleontological resources are encountered. WEAP training contents would be subject to review and approval by the Authority. Paleontological resources WEAP training may be provided concurrently with cultural resources WEAP training.

Upon completion of any WEAP training, the Contractor would require workers to sign a form stating that they attended the training and understood and would comply with the information presented. Verification of paleontological resources WEAP training will be provided to the Authority by the Contractor.

- **GEO-IAMF#15 Halt Construction, Evaluate, and Treat if Paleontological Resources Are Found:** Consistent with the PRMMP if fossil materials are discovered during construction, regardless of the individual making the discovery, all activity in the immediate vicinity of the discovery would halt and the find would be protected from further disturbance. If the discovery is made by someone other than the PRS or Paleontological Resource Monitors, the person who made the discovery would immediately notify construction supervisory personnel, who would in turn notify the PRS. Notification to the PRS would take place promptly (prior to the close of work the same day as the find), and the PRS would evaluate the find and prescribe appropriate treatment as soon as feasible. Work may continue on other portions of the CP while evaluation (and, if needed, treatment) takes place, as long as the find can be adequately protected in the judgment of the PRS.

  If the PRS determines that treatment (i.e., recovery and documentation of unearthed fossil[s]) is warranted, such treatment, and any required reporting, would proceed consistent with the PRMMP. The Contractor would be responsible for ensuring prompt and accurate implementation, subject to verification by the Authority. The stop work requirement does not apply to drilling operations, because drilling typically cannot be suspended in mid-course. However, if finds are made during drilling, the same notification and other follow-up requirements would apply. The PRS would coordinate with construction supervisory and drilling staff regarding the handling of recovered fossils. The requirements of this IAMF would be detailed in the PRMMP and presented as part of the paleontological resources WEAP training.

3.9.4.3 Method for NEPA and CEQA Impact Analysis

This section describes the sources and methods the Authority used to analyze potential impacts on GSSPR from implementation of the B-P Build Alternatives the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. These methods apply to both NEPA and CEQA unless otherwise indicated. Refer to Section 3.1.3.4, Methods for Evaluating Impacts, in Section 3.1, Introduction, for a description of the general framework for evaluating impacts under NEPA and CEQA.

Geology, Soils, and Seismicity

Impacts related to geology, soils, and seismicity are analyzed both quantitatively and qualitatively, based on a review of published geologic and soils information for the RSA and on professional judgment, in accordance with the current standard of care for geotechnical engineering and engineering geology. The impact analysis addresses both the impacts of the project on geologic resources and the impacts of geologic conditions and hazards on project design, construction, and operation.

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

This analysis used information from publicly available sources, such as the USGS, the CGS, Caltrans, the California Department of Water Resources, local planning departments, and published geologic reports and maps, to review and analyze the following geologic, soils, and seismic hazards:

- Surface rupture along hazardous faults
- Oil and gas operations

- Ground shaking
- Volcanic hazards
- Liquefaction and other seismically induced ground deformations
- Erosion and scour
- Surface water and groundwater
- Land subsidence
- Flooding and dam inundation
- Collapsible soils
- Tsunami and seiche
- Expansive soils
- Static and seismically induced landslides
- Soft, compressible soils
- Karst terrain
- Corrosivity
- Active or abandoned mines and quarries
- Hazardous minerals

CGS publications provided information on the mineral resource potential in the RSA (Cole 1988; Koehler 1999; Busch 2009). The Surface Mining and Reclamation Act of 1975 directs the state geologist to classify the nonfuel Mineral Resources Zones (MRZs) of the state to show where economically significant mineral deposits occur based on scientific data.

The California Division of Mines and Geology published Special Report 147, *Mineral Land Classification: Aggregate Materials in the Bakersfield Production-Consumption Region* (Cole 1988). Special Report 210, published in October 2009 (Busch 2009), reevaluates and updates Special Report 147. This updated report classifies sand and gravel deposits with material suitable for use as construction aggregate. It places emphasis on deposits of Portland cement concrete-grade aggregate; however, it also includes permitted deposits suitable for lower grades of aggregate use, such as asphaltic aggregate, base, sub-base, and fill. Only Portland cement concrete-grade deposits were placed in sectors for potential consideration for designation by the California Mining and Geology Board.

The analysis included a review of geotechnical data collected for the current conceptual level of design. The *Bakersfield to Palmdale Project Section: Geology, Soils, and Seismicity Technical Report* (Authority 2016c) summarizes these data. This report summarizes the geologic setting for the alignments, describes site conditions, and provides preliminary evaluations and recommendations for addressing geologic hazards, natural chemical hazards, and corrosion potential. The geotechnical information presented in the technical report and used in the analysis in this Draft EIR/EIS included representative boring logs along the alignments, as well as preliminary engineering interpretations. This report also summarizes the results of geotechnical explorations conducted by Caltrans and others along or within the vicinity of the HSR alignments. Further site-specific geotechnical investigations for the project would be conducted for the final engineering design. This information would be used for detailed design of specific structures and foundations.

In addition, the *Bakersfield to Palmdale Project Section: Feasibility Geotechnical Data Report* (Authority 2016a) presents the preliminary findings of an ongoing feasibility study for the proposed B-P Project Section of the California HSR System. The purpose of the feasibility geotechnical field investigation is to provide information about the subsurface soil, groundwater, and seismic conditions along the project section to increase the current geotechnical knowledge at select locations along the alignment with little existing information.

The investigation consisted of six geotechnical borings, seismic refraction surveys, and geologic mapping in the public right-of-way. The investigation was limited because permission to enter was not available for private property. The report recommends additional geotechnical borings along the alignment, especially in the vicinity of the tunnel portals, rail viaducts, local crossing bridges, and at-grade track within each of the geologic segments crossed by the alignment.

Paleontological Resources

The paleontological resources impact analysis was prepared consistent with the methods presented in the Society of Vertebrate Paleontology *Standard Procedures for the Assessment and Mitigation of Adverse Impacts to Paleontological Resources* (Society of Vertebrate Paleontology 2010) and the Caltrans *Standard Environmental Reference*, Environmental Handbook Vol. 1, Chapter 8 Paleontology (Caltrans 2014). The *Bakersfield to Palmdale Project*

Section Paleontological Resources Technical Report (Authority 2019) provides a detailed description of the evaluation methods, which are summarized below.

Because many fossils are buried in subsurface geologic units rather than exposed at the ground surface, an agency often cannot be certain whether any such resources would actually be encountered until earthwork for the project has commenced. As such, this paleontological resource impact analysis is largely based on probabilities of impact, with the goal of developing flexible strategies to support appropriate adaptive management in response to information that may arise during project planning and construction.

There are three steps in analyzing a project's potential to affect paleontological resources:

1. Identify the geologic units in the 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 impacts from project construction and operation based on the type and extent of ground-disturbing activity within paleontologically sensitive geologic units

A crucial working assumption in this approach is that a geologic unit that has produced fossils in the past has the potential to do so in other, nearby locations. In general, the same paleontological potential is considered to apply throughout the three-dimensional extent of the unit everywhere that unit occurs, regardless of whether or not fossils have been found in a given location.

To develop a baseline paleontological resource inventory of the RSA and to assess the potential paleontological productivity of each geologic unit present in the RSA, qualified paleontologists reviewed the published and available unpublished geological and paleontological literature and databases, and compiled, synthesized, and evaluated stratigraphic and paleontological inventories. Paleontologists also conducted a field survey, including visual inspection of exposures of potentially fossiliferous strata in the RSA, to document the presence of sediments suitable for containing fossil remains and the presence of any previously unrecorded fossil sites.

Geologic units were then classified for paleontological potential (or sensitivity) based on the relative abundance of vertebrate fossils and significant nonvertebrate fossils using the Caltrans (2014) sensitivity ratings of high, low, and no paleontological potential. Table 3.9-2 defines the sensitivity ratings used for the purpose of this assessment. The table identifies potential impacts on paleontological resources where surface work would occur in areas mapped with "high paleontological sensitivity" or where ground disturbance at depths greater than 5 feet would occur in areas mapped as "high paleontological sensitivity at depth." Direct impacts on paleontological resources occur when earthwork activities (e.g., grading or trenching) cut into the geologic units (e.g., formations) within which fossils are buried and physically destroy the fossils.

Table 3.9-2 California Department of Transportation Paleontological Sensitivity Rating Criteria

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

Source: California Department of Transportation, 2014

3.9.4.4 Method for Determining Significance under CEQA

CEQA requires that an EIR identify the significant environmental impacts of a project (CEQA Guidelines § 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a threshold-based analysis of the impacts (see Section 3.1.3.4 for further information). Accordingly, Section 3.9.9, CEQA Significance Conclusions, summarizes the significance of the environmental impacts on geology, soils, and seismicity, and paleontological resources for each of the HSR Build Alternatives. The Authority is using the following thresholds to determine whether a significant impact would occur as a result of the B-P Build Alternatives, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities.

Geology, Soils, and Seismicity

Based on the *CEQA Guidelines,* the project would have a significant impact if it:

- Directly or indirectly exposed 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 seismic activity or its related hazards, including fault rupture, 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 the productivity of farming present in the area.
- 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 of structures to destruction due to geologic hazards, such as primary and secondary seismic hazards.
- Is constructed on expansive soil or corrosive soils, as defined in Table 18-1-B of the Uniform Building Code (1994 [or the most recent applicable Uniform Building Code, IBC, or the

California Building Standards Code), and would result in an increased direct or indirect exposure of people to loss of life or of structures to destruction as a result of the soils' nature (for instance, causing the collapse of the structure).

- 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 at the 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

Based on the *CEQA Guidelines,* the project would have a significant impact if it:

- Directly or indirectly destroys a unique paleontological resource or site or unique geologic feature.[4]

Unless field surveys identify fossils at the surface in a proposed project's footprint, it cannot be determined with certainty that project-related construction activity would damage or destroy scientifically significant paleontological resources. The paleontological evaluation is thus based on the presence of geologic units with high paleontological sensitivity that would or could be directly disturbed during construction activity.

3.9.5 Affected Environment

The affected environment includes the physiography and regional geologic setting, the geology of the proposed B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, the LMF/MOWF/MOIS facilities, site soils, and hazards in the RSA. Hazards in the RSA include geologic hazards, primary seismic hazards, secondary seismic hazards, soil-related hazards, areas of difficult excavation, hazardous minerals, and energy resources. The defined affected environment is used to describe the context by which the evaluation will be made to determine whether GSSPR impacts are significant under NEPA and CEQA. The affected environment related to GSSPR does not vary substantially among the B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. Therefore, the following discussion applies to all of the B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities.

3.9.5.1 Fresno to Bakersfield Locally Generated Alternative from the Intersection of 34th Street and L Street to Oswell Street

The GSSPR affected environment for the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street is included in Section 3.9.3 of the *Fresno to Bakersfield Section Draft Supplemental EIR/EIS* (Authority and FRA 2017). However, the affected environment discussions included in Sections 3.9.5.2 through 3.9.5.4 below also reflect this portion of the F-B LGA between the intersection of 34th Street and L Street to Oswell Street.

[4] Significant paleontological resources include those that provide taxonomic, phylogenetic, ecologic, or stratigraphic and geochronologic data. They may include any or all of the following types of remains: various types of body fossils, casts and impressions, trace fossils, and tracks and trackways, as well as some types of nest and midden deposits. Plant, animal, and microfossil remains may all qualify. Vertebrate fossils of all types are considered scientifically important because of their comparative rarity.

3.9.5.2 Physiography and Regional Geologic Setting

The physiography and regional geologic setting is consistent for paleontological resources and geology, soils, and seismicity. This analysis therefore considers these two disciplines together.

Portions of the Bakersfield to Palmdale Project Section are in the Great Valley, Sierra Nevada, Mojave Desert, and Transverse Ranges geomorphic provinces of California (Wagner 2002) (Figure 3.9-1).

- **Great Valley**—Extends from the Bakersfield Station southeastward for approximately 17 miles to where the B-P Build Alternative alignment enters the Tehachapi Mountains
- **Sierra Nevada**—Begins approximately 17 miles southeast of the Bakersfield Station and continues for approximately 31 miles southeastward to the north side of the Antelope Valley near the community of Mojave
- **Mojave Desert**—Begins at the southern end of the Sierra Nevada province and extends southward approximately 35 miles to the Palmdale Station
- **Transverse Ranges**—Begins approximately at the Palmdale Station and extends southward for approximately 2.4 miles

Great Valley Geomorphic Province

The northwestern portion of the project section lies within the San Joaquin Valley, the southernmost portion of the Great Valley geomorphic province, an elongated basin between the Sierra Nevada and the California Coast Ranges. The San Joaquin Valley is a broad, north-south-trending, structural trough bounded on the north by the Sacramento-San Joaquin River Delta and the Sacramento Valley, on the south by the San Emigdio and Tehachapi Mountains, on the east by the Sierra Nevada, and on the west by the Coast Ranges.

Topography in the San Joaquin Valley portion of the Bakersfield to Palmdale Project Section is generally level, with a regional gentle slope of approximately 0.3 percent from the east-northeast toward the west-southwest. Elevations in this portion of the alignment mostly range from about 348 to 450 feet above mean sea level, with isolated elevation highs and lows at embankments and channels.

The structure of the San Joaquin Valley is a west-dipping, asymmetric syncline characterized by block faulting and folding. The Valley includes a structural trough in which Miocene and Pliocene sediment deposits exist to a depth of 30,000 feet and is the site of several major oil fields.

The sequence of Tertiary marine and nonmarine sediment includes Holocene to Middle Pleistocene-age unconsolidated sediments consisting of alluvial fan deposits, older alluvium, and lake and floodplain deposits. Thick sedimentary marine deposits underlie the unconsolidated alluvial soils and rest on southwest-dipping basement rock composed of Mesozoic-age igneous rock and pre-Jurassic metamorphic rock (CGS 2002).

Sierra Nevada Geomorphic Province

The central portion of the B-P Project Section traverses the Tehachapi Mountains, located at the southern tip of the Sierra Nevada geomorphic province. The Sierra Nevada province is a tilted fault block that separates the Great Valley on the west from the Basin and Range province to the east. The Sierra Nevada is approximately 400 miles long, with a steep eastern escarpment and a relatively gentle western slope. The majority of bedrock in the Sierra Nevada is granitic igneous rock of Cenozoic age, although older metamorphic and younger volcanic rocks are present as well.

In marked contrast to the San Joaquin Valley, the topography of the Tehachapi Mountains is generally rugged, with the exception of the intermontane Tehachapi Basin. Slopes are steep, often exceeding 30 percent. The project section traverses the Sierra Nevada province in an area where elevations are generally below 4,000 feet. Nearby peaks rarely exceed 5,000 feet.

Figure 3.9-1 California Geomorphic Provinces

The White Wolf and Garlock faults define the structure of the Tehachapi Mountains. The left-lateral fault movement of the Garlock fault has uplifted the Tehachapi Mountains along the reverse White Wolf fault and shifted them into an east-west trend. The Tehachapi Mountains primarily consist of Mesozoic granitic rock with isolated bands of metasedimentary rock (CGS 2002).

Mojave Desert Geomorphic Province

The southern portion of the B-P Project Section traverses the Antelope Valley in the Mojave Desert geomorphic province. The Garlock fault forms the boundary between the Sierra Nevada and Mojave Desert geomorphic provinces. The San Andreas fault marks the western boundary of this province and separates it from the Transverse Ranges province. This province is characterized by isolated mountain ranges separated by alluvium-covered desert plains.

The topography of the Mojave Desert is generally level with isolated hills abruptly rising from the desert floor. Regionally, the desert floor slopes toward the center of the Antelope Valley. Elevations along the Mojave Desert subsection of the project section vary from a height of approximately 3,300 feet near the Garlock fault on the north end of this subsection to a low of approximately 2,300 feet in the middle of the Antelope Valley, then increase to the southeast along the alignment.

The Antelope Valley is elevated desert terrain located along the western edge of the Mojave Desert. The Antelope Valley is covered primarily by alluvial deposits of Quaternary age. Holocene alluvial deposits consist of slightly dissected alluvial fan deposits of gravel, sand, and clay. Near the margins of the valley, Pleistocene older alluvium consists of weakly consolidated, uplifted and moderately to severely dissected alluvial fan and terrace deposits composed primarily of sand and gravel (CGS 2002).

Transverse Ranges Geomorphic Province

The southernmost portion (2.4 miles) of the project traverses the Transverse Ranges geomorphic province. The Transverse Ranges geomorphic province is an east-west-trending series of steep mountain ranges and valleys; the east-west structure is oblique to the normal northwest trend of coastal California (hence the name “Transverse”). Its eastern edge near the San Bernardino Mountains has been displaced to the south along the San Andreas fault. This geomorphic province is one of the most rapidly rising regions on earth due to intense north-south compression, and folding and faulting of thick petroleum-rich sedimentary rocks has created an important oil-producing region (CGS 2002).

The main structural feature in the region is the northwest-trending, active San Andreas fault system.

3.9.5.3 Geology, Soils, and Seismicity-Specific Setting

Surficial Geology

Surficial geology underlying the RSA varies by location and subsection. Figure 3.9-2 (Sheets 1 through 3) shows the surficial geology, and Table 3.9-3 provides a summary of information on mapped surficial geologic units.

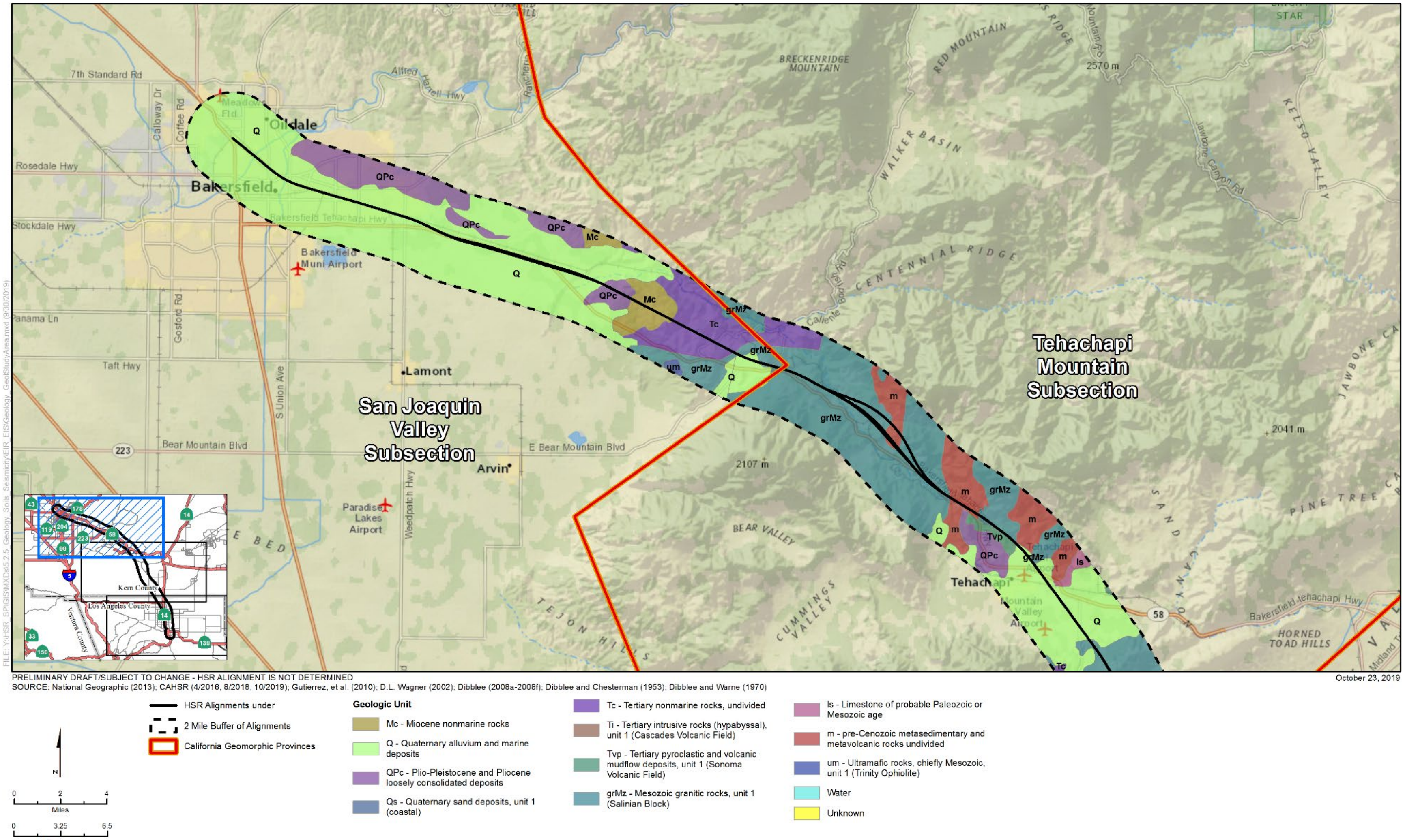


Figure 3.9-2 Surficial Geology within the Resource Study Area

(Sheet 1 of 3)

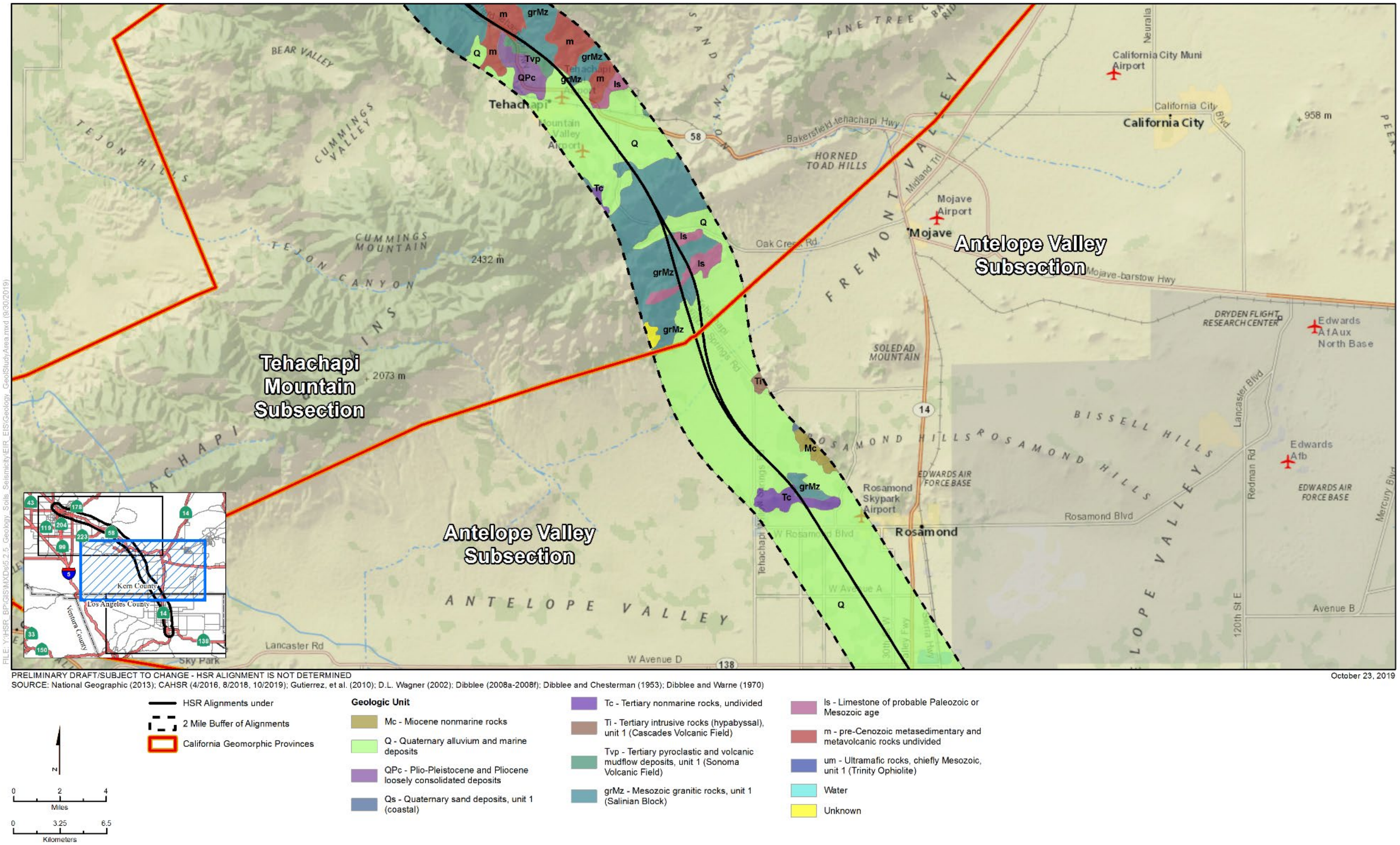


Figure 3.9-2 Surficial Geology within the Resource Study Area

(Sheet 2 of 3)

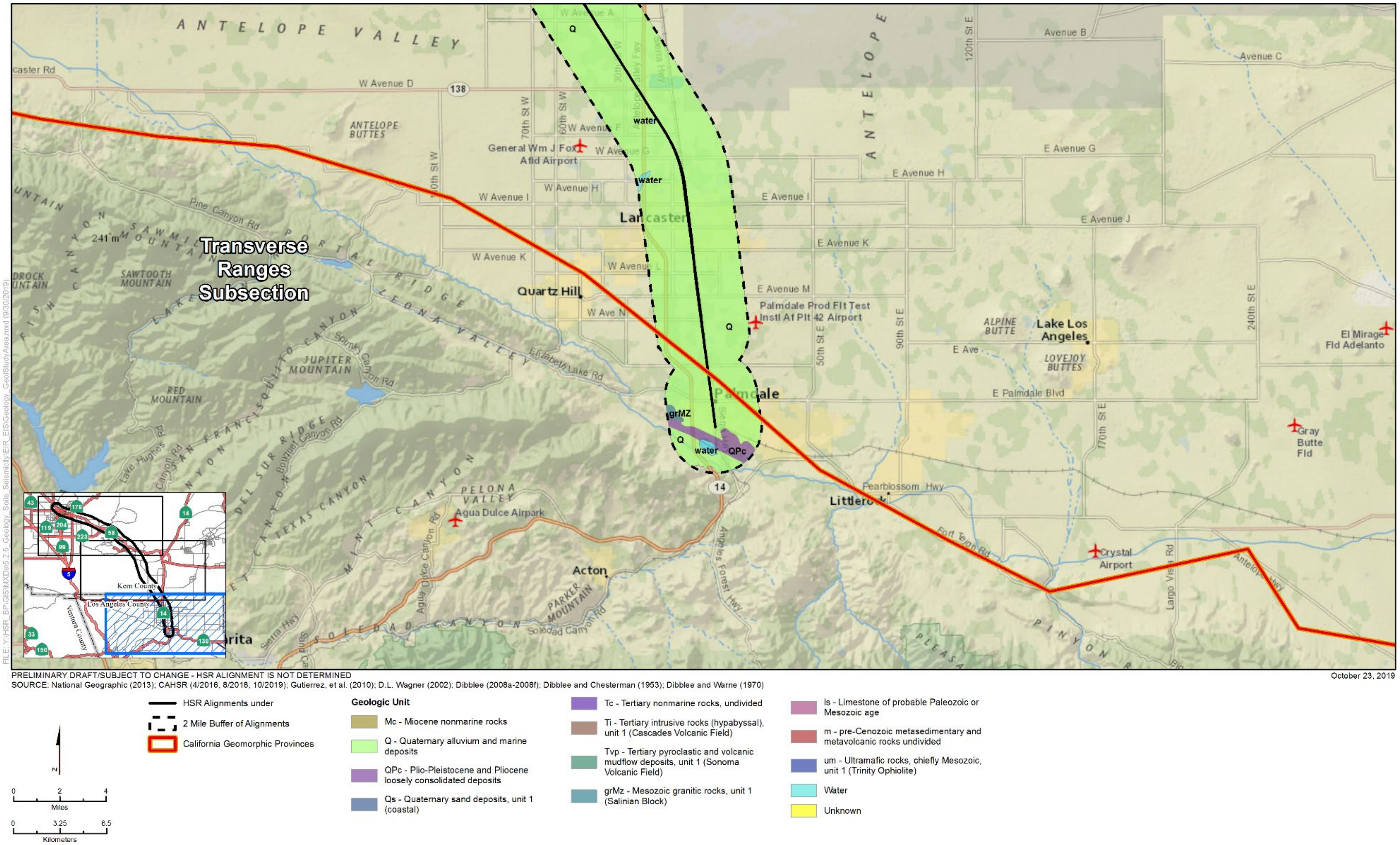


Figure 3.9-2 Surficial Geology within the Resource Study Area
(Sheet 3 of 3)

Table 3.9-3 Summary of Geologic Units Along the Bakersfield to Palmdale Project Section

Map Symbol	Description
Qs	Quaternary (Holocene) extensive unconsolidated, nonmarine sand deposits in and near desert playas; similar marine and nonmarine deposits mapped near the coast
Q	Quaternary (Holocene-Pleistocene) unconsolidated and semi-consolidated alluvial lake, playa, and terrace deposits; mostly nonmarine but includes marine deposits near the coast
QPc	Quaternary-Tertiary (Pleistocene-Pliocene) mostly loosely consolidated sandstone, shale, and gravel deposits
Mc	Tertiary (Miocene) moderately to well-consolidated sandstone, shale, conglomerate, and fanglomerate
Tc	Tertiary (Pliocene-Paleocene) sandstone, shale, conglomerate, breccia, and ancient lake deposits
Tvp	Tertiary (Pliocene-Paleocene) pyroclastic and volcanic mudflow deposits
Ti	Tertiary (Pliocene-Paleocene) intrusive rocks; mostly shallow (hypabyssal) plugs and dikes
grMz	Mesozoic granite, quartz monzonite, granodiorite, and quartz diorite
um	Mainly Mesozoic ultramafic rocks, including mostly serpentine with minor amounts of peridotite, gabbro, and diabase
ls	Mesozoic-Paleozoic limestone, dolostone, and marble
m	Mesozoic-Precambrian metasedimentary and metavolcanic rocks of great variety; mostly slate, quartzite, hornfels, chert, phyllite, mylonite, schist, gneiss, and minor marble

Source: Gutierrez, et al., 2010; Geologic Map of California, California Geological Survey California Geologic Data Map Series, Map No. 2, Map Scale: 1: 750,000

Refer to Figure 3.9-1 (Sheets 1 through 3) for correlation with map geologic units.

San Joaquin Valley Subsection

In the San Joaquin Valley, the B-P Project Section crosses Quaternary alluvial and older alluvial deposits from the vicinity of Oswell Street to the eastern end of this subsection near Caliente Creek. The portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street is located on similar surficial geological units as the rest of the B-P Project Section (please refer to the *Fresno to Bakersfield Section Draft Supplemental EIR/EIS,* Chapter 3.9, Figure 3.9-1 [Authority and FRA 2017]). The surficial geology comprises largely alluvial, fan, and lacustrine deposits. The majority of the alluvial deposits consist of sediment and gravels carried by the rivers from the Sierra Nevada and deposited as large alluvial fans, which extend westward across most of the San Joaquin Valley (Bartow 1984, 1991; Bartow and McDougall 1984; Olsen et al. 1986; Metz 1986). This material consists of silt, sands, and gravels. Cobbles and boulders are also present close to rivers and streams, where fluvial energy is capable of transporting larger clasts.

Tehachapi Mountains Subsection

The Tehachapi Mountains subsection of the project traverses the rugged mountainous terrain between the San Joaquin Valley and the Antelope Valley. This is the most mountainous portion of the entire B-P Project Section. Elevations along this subsection of the proposed alignment range from 850 feet to 3,800 feet above mean sea level. In the Tehachapi Mountains, the underlying geology transitions first to Tertiary-aged conglomerate and sandstone, and then, as one travels from south to north, to igneous and metamorphic rock units dominated by Mesozoic-age igneous quartz diorite and Paleozoic-age schist, gneiss, marble, and quartzite (Bateman 1992; Buwalda 1954; Lawson 1906). The B-P Project Section overlies the northern end of the Tehachapi Valley, east of the community of Golden Hills, and crosses Holocene alluvium.

The B-P Project Section crosses the active White Wolf fault about 2 miles southeast of the Edison fault and 21 miles northwest of the City of Tehachapi, and crosses the active Garlock fault about 7 miles southeast of Tehachapi. The Garlock fault is a left-lateral, primarily strike-slip fault that creates a major geomorphic boundary between the mountainous Sierra Nevada province and the much flatter Mojave Desert province. The White Wolf fault is a reverse fault with a left-lateral component of slip. It was the source of the July 21, 1952, 7.3 moment magnitude (M) earthquake.

Antelope Valley Subsection

The Mojave Desert subsection of the B-P Project Section primarily traverses alluvial deposits eroded from the Tehachapi Mountains to the north, the San Gabriel Mountains to the south, and several isolated peaks within the Antelope Valley. The B-P Project Section overlies the Mojave Desert geomorphic province, crossing the Garlock fault. Mesozoic quartz monzonite underlies a steep northeast-trending ridge on the south side of the fault (Dibblee 2008e). The B-P Project Section traverses alluvial fans on the south side of this ridge and then crosses relatively flat-lying recent alluvial deposits and low sand dunes (Ponti 1985). The B-P Project Section passes on the west side of Soledad Mountain, a steep-sided peak of Tertiary-age volcanic tuff, porphyry, and felsite (Dibblee 2008d, 2008c). West of Rosamond, the alignment crosses the Rosamond Butte, which is underlain by Tertiary nonmarine rocks and Mesozoic granitic rocks.

State Mineral Resource Zones

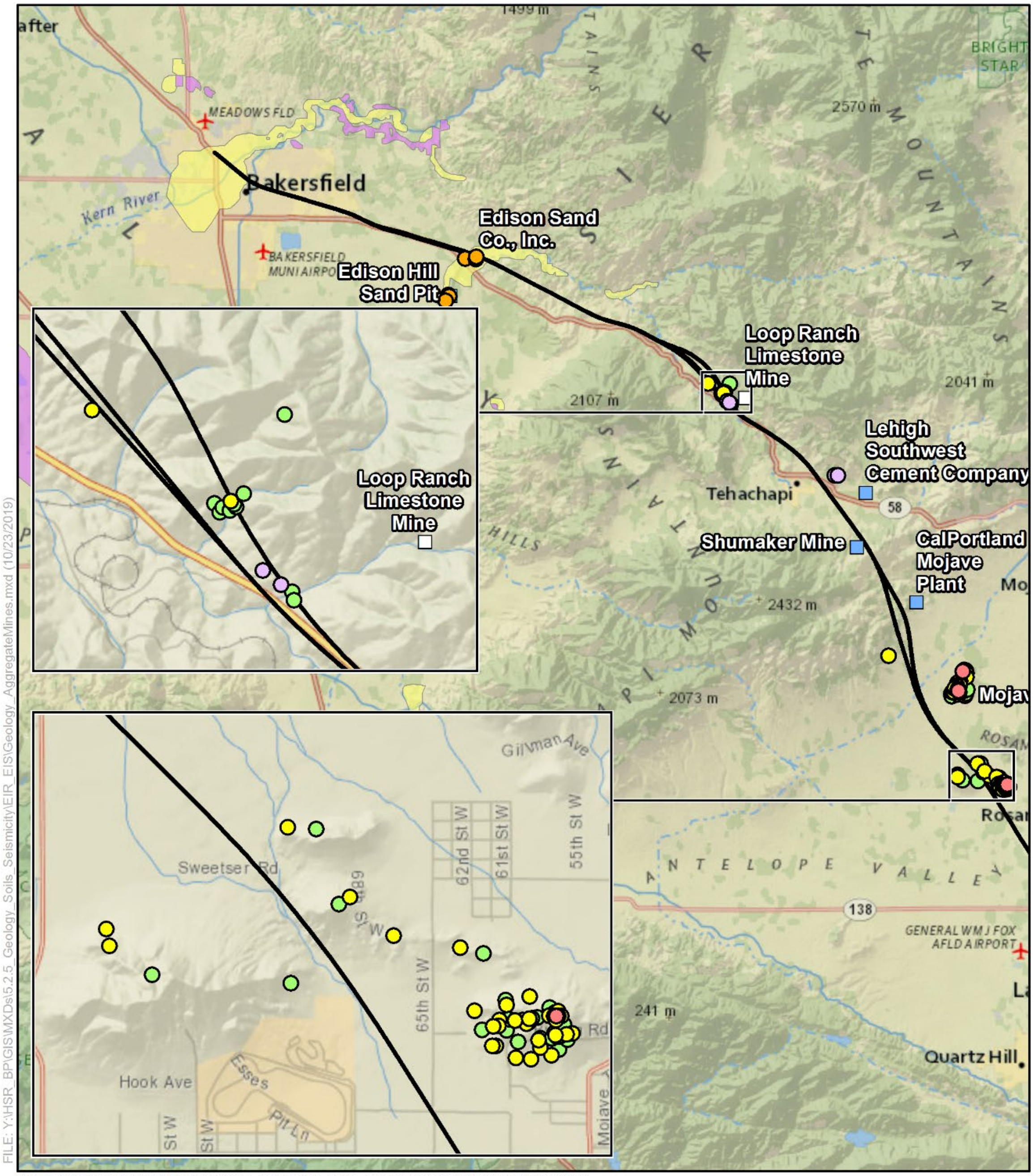
The CGS classifies the land it studies as MRZs 1 through 3:

- **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

The CGS further subdivides the above MRZs with the suffixes “a” and “b.” An “a” suffix indicates demonstrated mineral reserves, and a “b” suffix indicates inferred mineral reserves. For example, MRZ-2a represents that there is adequate information to indicate that demonstrated reserves of significant mineral deposits exist.

A review of the Bakersfield RSA relative to the published update indicates that MRZ-2 conditions apply to about a 1.3-mile-long segment of the alignment where it crosses the Caliente Creek floodplain (this area includes the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street). As shown on Figure 3.9-3, the B-P Project Section would cross narrow areas of MRZ-2 that exist along the channel of Caliente Creek farther to the east. While the project would cross this region, the project would not impede mining from occurring in the area surrounding the alignment. All other portions of the alignment in the Bakersfield Production-Consumption area are designated MRZ-3.

Farther to the southeast, the project passes on the southwest side of Soledad Mountain over an area classified as MRZ-3a and MRZ-3b for gold production. The southernmost portion of the project is in an area classified as MRZ-3.



FILE: Y:\HSR_BP\GIS\MXDs\5.2.5_Geology_Soils_Seismicity\EIR_EIS\Geology_AggregateMines.mxd (10/23/2019)

PRELIMINARY DRAFT/SUBJECT TO CHANGE - HSR ALIGNMENT IS NOT DETERMINED

October 23, 2019

SOURCE: National Geographic (2014); CAHSR (4/2016, 8/2018, 10/2019); USGS (2003); CA Dept. of Conservation - Office of Mine Reclamation (2016)

N

0 4.5 9 Miles

0 7.25 14.5 Kilometers

HSR Alignments under Consideration

Mineral Resource Zones

MRZ 1 (Little Likelihood for the Presence of Significant Mineral Resources)

MRZ 2 (Significant Mineral Deposits Present)

Mine Locations (USGS)

Mineral

Sand And Gravel

Mines - Active/Abandoned (U.S. Dept. of Conservation)

Mine Shaft

Mine Tunnel

Open Pit

Quarry

Sand Pit

Figure 3.9-3 Aggregate Mines

Site Soils

Natural Resources Conservation Service soil surveys describe soils associated with the proposed B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities (USDA/NRCS 2015). Figure 3.9-4 (Sheets 1 through 3) shows the soil associations in the RSA. The Natural Resources Conservation Service mapping is very general in nature, and site-specific geotechnical studies would be conducted that include soils borings and testing. Table 3.9-4 provides a summary of the physiographic features, soil associations, and counties of occurrence.

San Joaquin Valley and Antelope Valley

Soils form primarily on gently sloping alluvial fan and plain environments in the San Joaquin Valley and Antelope Valley subsections of the B-P Build Alternatives and the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street. The sediments from which the soils derive are primarily of granitic composition. These soils generally are low in clay content, deep, and well drained. They exhibit moderate alkalinity, low to moderate shrink-swell potential, moderate to high corrosion to uncoated steel, and slight to moderate corrosion to concrete. Some of these soils also have high potential for water and wind erosion. In the Great Valley subsection, soils are predominantly of the Zerker-Premier-Delano-Chanac association and Wasioja-Hesperia-Arvin association. Soils are predominantly of the Wasco-Rosamond-Cajon association, Hi Vista-Calvista-Cajon-rock outcrop association, and Rosamond-Playas-Gila-Cajon association in the Mojave Desert subsection (Figure 3.9-4, Sheets 1 through 3).

Tehachapi Mountains

Soils in the Tehachapi Mountains subsection have formed from weathering of underlying bedrock materials primarily on gentle to steep slopes. Soil map units found in this part of the project vicinity include rocky outcrops and shallow, well-drained soils underlain by weathered bedrock. Some deeper soils, including the Anaverde Series, are found on hillslopes. These soils are moderately to highly corrosive to uncoated steel, exhibit low to moderate shrink-swell potential, and have low to moderate potential for water and wind erosion. These soils are generally of the Walong-rock outcrop–Edmonston-Anaverde association (Figure 3.9-4, Sheets 1 through 3). In the vicinity of the Tehachapi Valley, the soils form in flat to gently sloping, young sandy alluvial deposits that fill the valley bottom. These soils are Tehachapi-Steuber-Havala association.

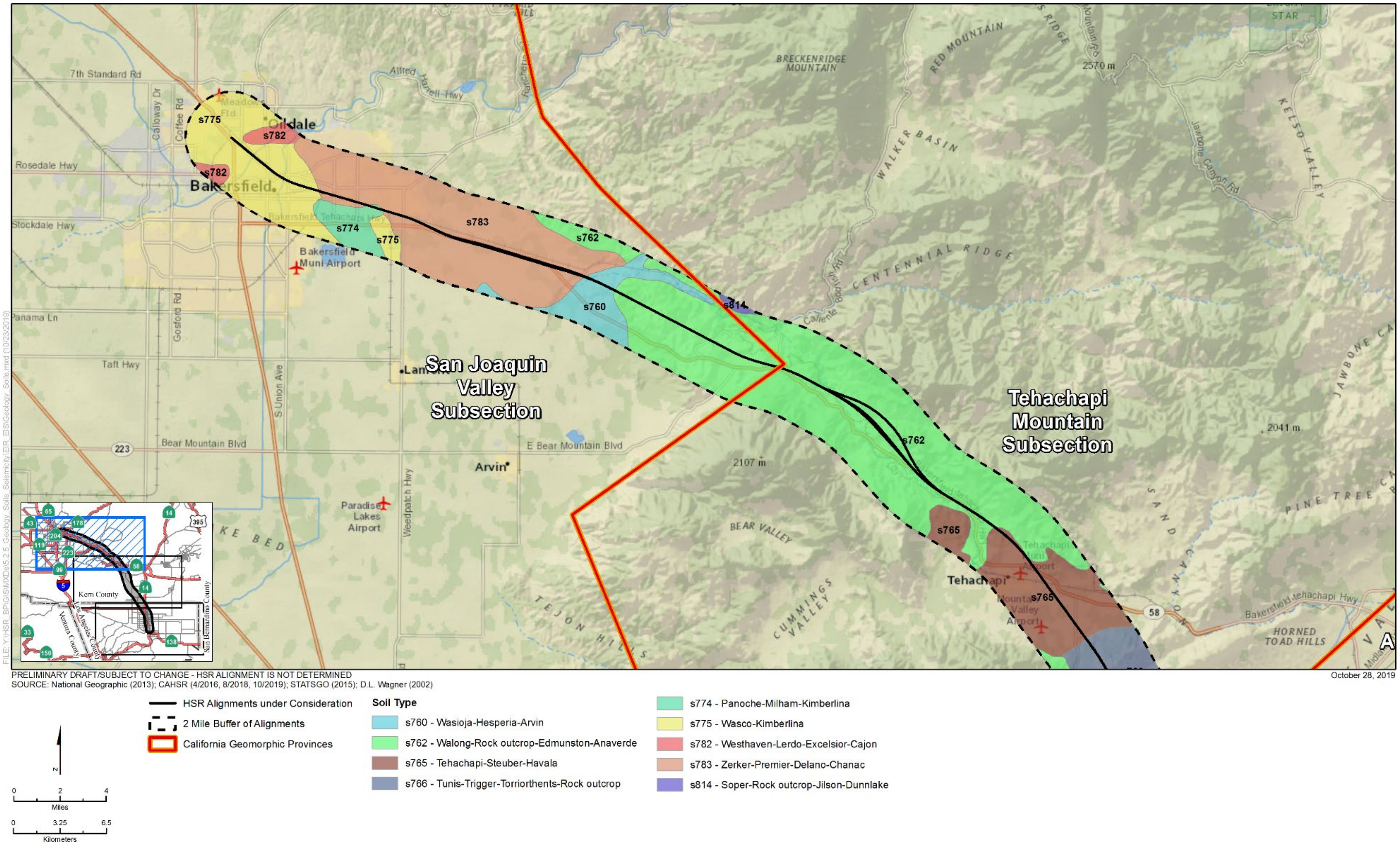


Figure 3.9-4 Soil Associations in the Resource Study Area

(Sheet 1 of 3)

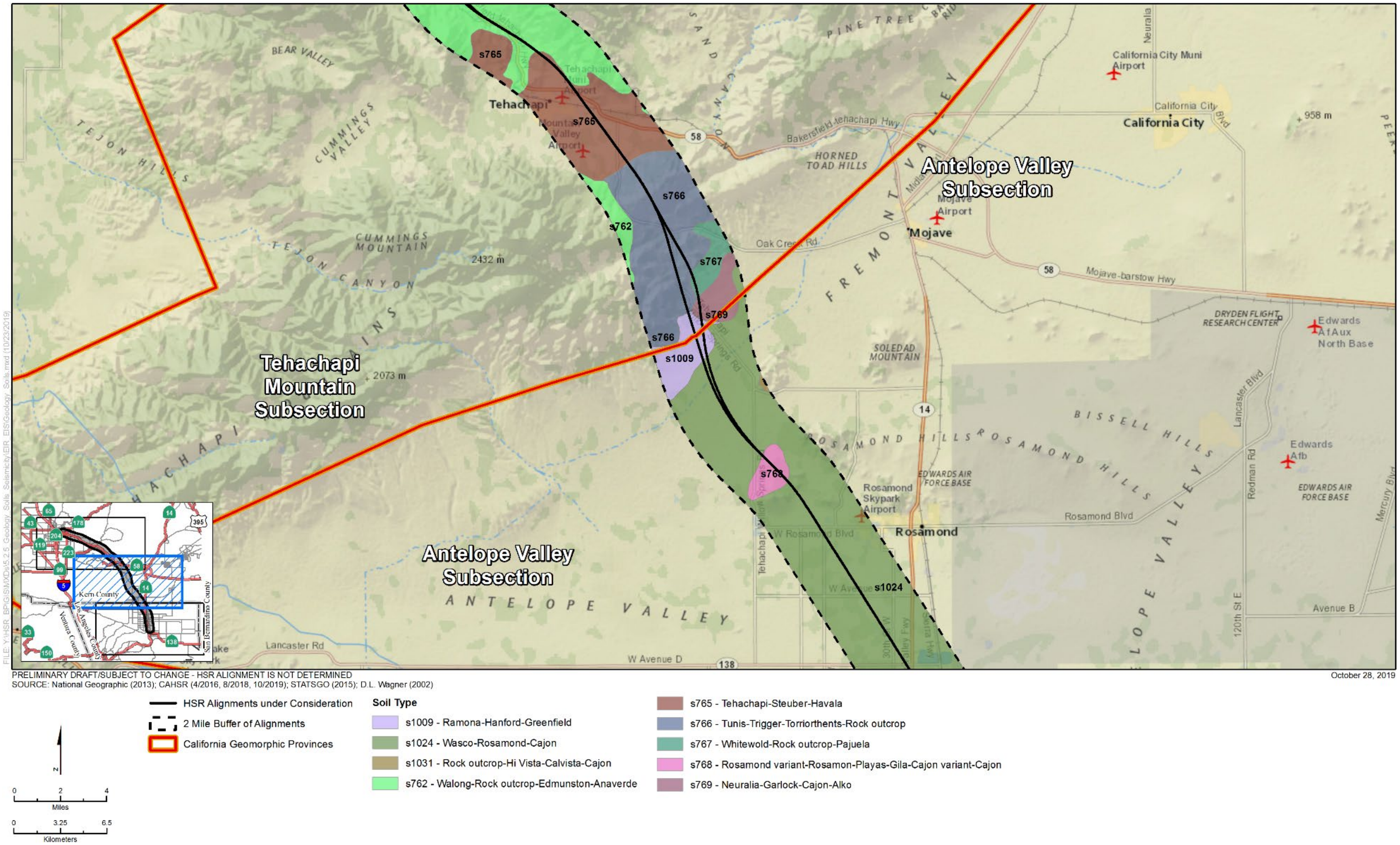


Figure 3.9-4 Soil Associations in the Resource Study Area

(Sheet 2 of 3)

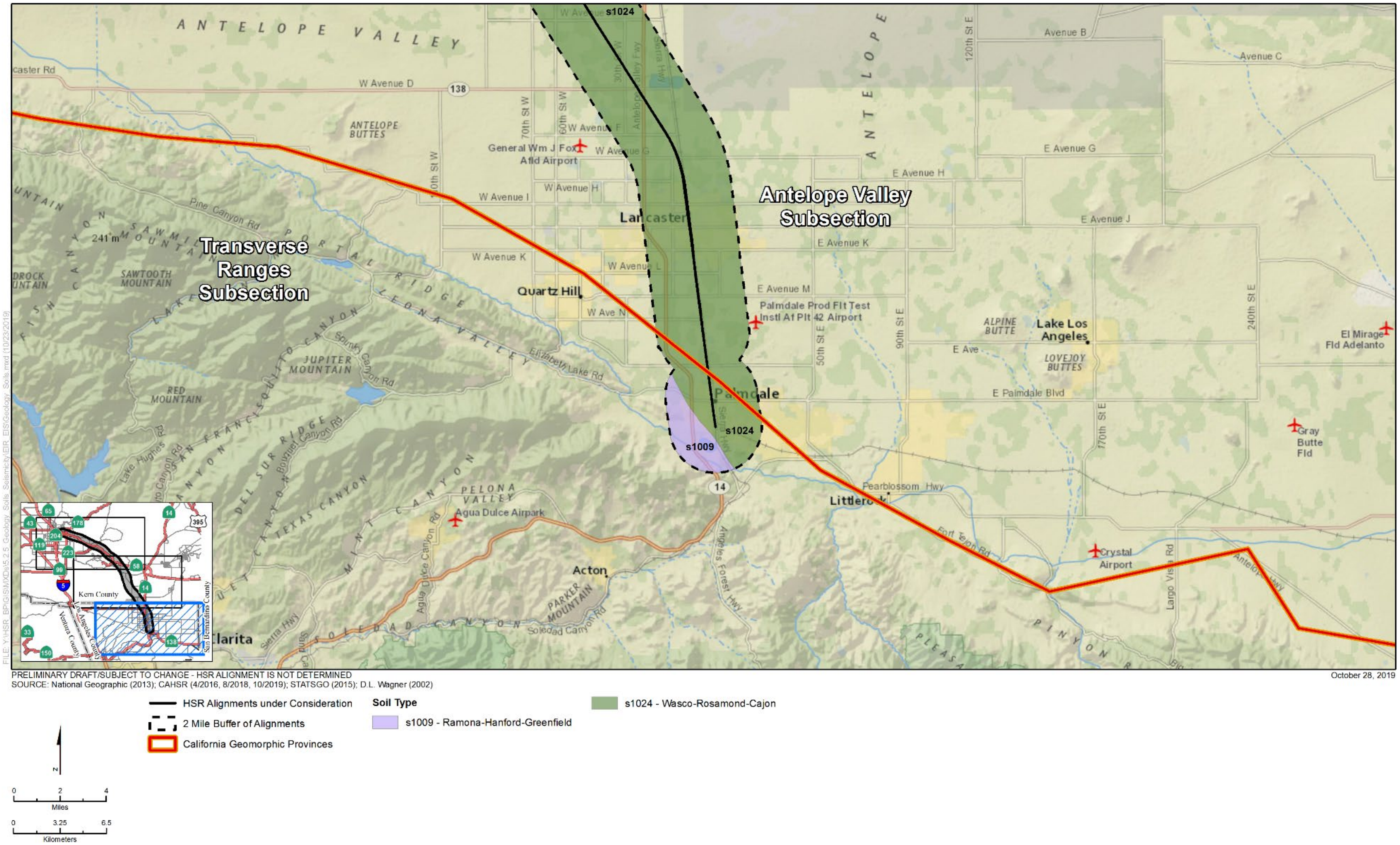


Figure 3.9-4 Soil Associations in the Resource Study Area

(Sheet 3 of 3)

Table 3.9-4 Soil Types in the Resource Study Area

Soil Association	Map Units	Geomorphic Province	Counties of Occurrence	Landform Groups	Soil Hazards	Drainage/Runoff/ Permeability
Wasioja-Hesperia-Arvin	S760	San Joaquin Valley	Kern	Alluvial plains and terraces	Highly corrosive to steel, slightly to moderately corrosive to concrete, moderately expansive	Well drained/negligible to high runoff/moderately slow permeability
Walong-rock outcrop-Edmonston-Anaverde	S762	Sierra Nevada	Kern	Mountains	Moderately corrosive to steel	Well drained/medium to very rapid runoff/ moderately rapid permeability
Tehachapi-Steuber-Havala	S765	Sierra Nevada	Kern	Alluvial mountain valley fill	Highly corrosive to steel	Well drained/slow to medium runoff/slow permeability
Tunis-Trigger-Torriorthents-rock outcrop	S766	Sierra Nevada	Kern	Mountains	Highly corrosive to steel	Well drained/medium to rapid runoff/moderate permeability
White Wolf-rock outcrop-Pajuela	S767	Sierra Nevada	Kern	Lower hill slopes and upper fans	Highly corrosive to steel	Well drained/slow runoff/ rapid permeability
Rosamond-Playas-Gila-Cajon	S768	Mojave Desert	Kern and Los Angeles	Alluvial plains and terraces	Highly corrosive to steel, slightly to moderately corrosive to concrete, moderately expansive	Generally well drained/ medium runoff/moderate to moderately slow permeability
Neuralia-Garlock-Cajon-Alko	S769	Mojave Desert	Kern	Upper alluvial fans	Moderately corrosive to concrete, highly corrosive to steel	Well drained/slow and medium runoff/ moderately slow permeability
Panoche-Milham-Kimberlina	S774	San Joaquin Valley	Kern	Alluvial plains and terraces	Highly corrosive to steel, highly erodible, moderately expansive	Well drained/negligible to medium runoff/moderate permeability

Soil Association	Map Units	Geomorphic Province	Counties of Occurrence	Landform Groups	Soil Hazards	Drainage/Runoff/ Permeability
Wasco-Kimberlina	S775	San Joaquin Valley	Kern	Alluvial plains and terraces	Highly corrosive to steel	Well drained/negligible or very low runoff/ moderately rapid permeability
Westhaven-Lerdo-Excelsior-Cajon	S782	San Joaquin Valley	Kern	Alluvial plains and terraces	Moderately corrosive to steel, low corrosive to concrete	Well drained/low runoff/moderately slow permeability
Zerker-Premier-Delano-Chanac	S783	San Joaquin Valley	Kern	Alluvial plains and terraces	Low shrink-swell, highly corrosive to steel, highly corrosive to concrete	Well drained/slow or medium runoff/ moderately slow permeability
Soper-rock outcrop-Jilson-Dunnlake	S814	Sierra Nevada	Kern	Mountains	Moderately corrosive to steel	Well drained/rapid runoff/ moderately slow permeability
Ramona-Hanford-Greenfield	S1009	Mojave Desert	Los Angeles	Alluvial plains and terraces	Highly corrosive to steel	Well drained/slow to rapid runoff/moderately slow permeability
Wasco-Rosamond-Cajon	S1024	Mojave Desert	Kern	Alluvial plains and terraces	Highly corrosive to steel, slightly to moderately corrosive to concrete, low shrink-swell	Well drained/ negligible or very low runoff/ moderately rapid permeability
Rock outcrop-Hi Vista-Calvista-Cajon	S1031	Mojave Desert	Kern	Alluvial plains and terraces	Moderately corrosive to steel moderately corrosive to concrete	Well drained/medium, high or very high runoff/ moderately slow permeability

Source: Natural Resources Conservation Service, 2015
Refer to Figure 3.9-4 (Sheets 1 through 3) for correlation with map units.

Geologic, Soils, and Seismic Hazards within the Specific Setting

Soil Hazards

Expansive Soils
Expansive soils are those that undergo a significant increase in volume during wetting and shrink in volume as they dry. Expansive soils can cause significant damage to structures due to increases in uplift pressures. Soils are generally classified as having low, moderate, and high expansive potentials.

Table 3.9-4 indicates the expansive potential of the various soil units in the B-P Project Section, and Figure 3.9-5 illustrates the shrink-swell classification of soils in the RSA. As illustrated on this figure, the potential for highly expansive soils along the alignment occurs where the alignment intersects Caliente Bodfish Road on the northern side of the Tehachapi Mountains.

Moderately expansive soil potential exists in discrete locations along the B-P Project Section, including:

- Along the south side of the alignments, near the northwestern end of the B-P Project Section and the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street
- In the vicinity of Caliente Creek
- In the Tehachapi Valley
- Within the RSA, near the southwestern end of the project section

Corrosive Soils
Soil corrosivity involves the measure of the potential for corrosion of steel and concrete due to contact with certain types of soil. Knowledge of potential soil corrosivity is 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. Soils with high moisture content, high electrical conductivity, high acidity, and high dissolved salts content are most corrosive. In general, sandy soils have resistivities and are the least corrosive. Clayey soils, including those that contain interstitial high salt water, can be highly corrosive. Table 3.9-4 shows soil types with the potential to cause corrosion to infrastructure related to the B-P Project Section.

Figure 3.9-6 illustrates that soils highly corrosive to concrete occur at the north of Caliente Creek and north of Tehachapi, and moderately corrosive soils occur northwest of Rosamond. In addition, moderately corrosive soils are found near the south side of the alignment near Caliente and near the station in Palmdale.

Figure 3.9-7 illustrates potential corrosivity between native soils along the project section and buried, uncoated steel. In this case, all of the alignment exhibits a moderate to high potential for corrosivity except in scattered areas where corrosivity data have not been recorded. It is likely that these soils are also moderately to highly corrosive to uncoated steel.

Collapsible Soils
Collapsible soils are soil layers that collapse (settle) when water is added under loads. This phenomenon is also known as hydroconsolidation. Natural deposits susceptible to hydroconsolidation are typically aeolian, alluvial, or colluvial materials with high apparent strength when dry. Manufactured fills that are loose and unconsolidated may also be subject to collapse. When irrigation water or a rise in the groundwater table results in saturation of these soils, pores and voids between the soil particles disappear and the soils collapse.

Collapsible soils exist within the San Joaquin Valley.

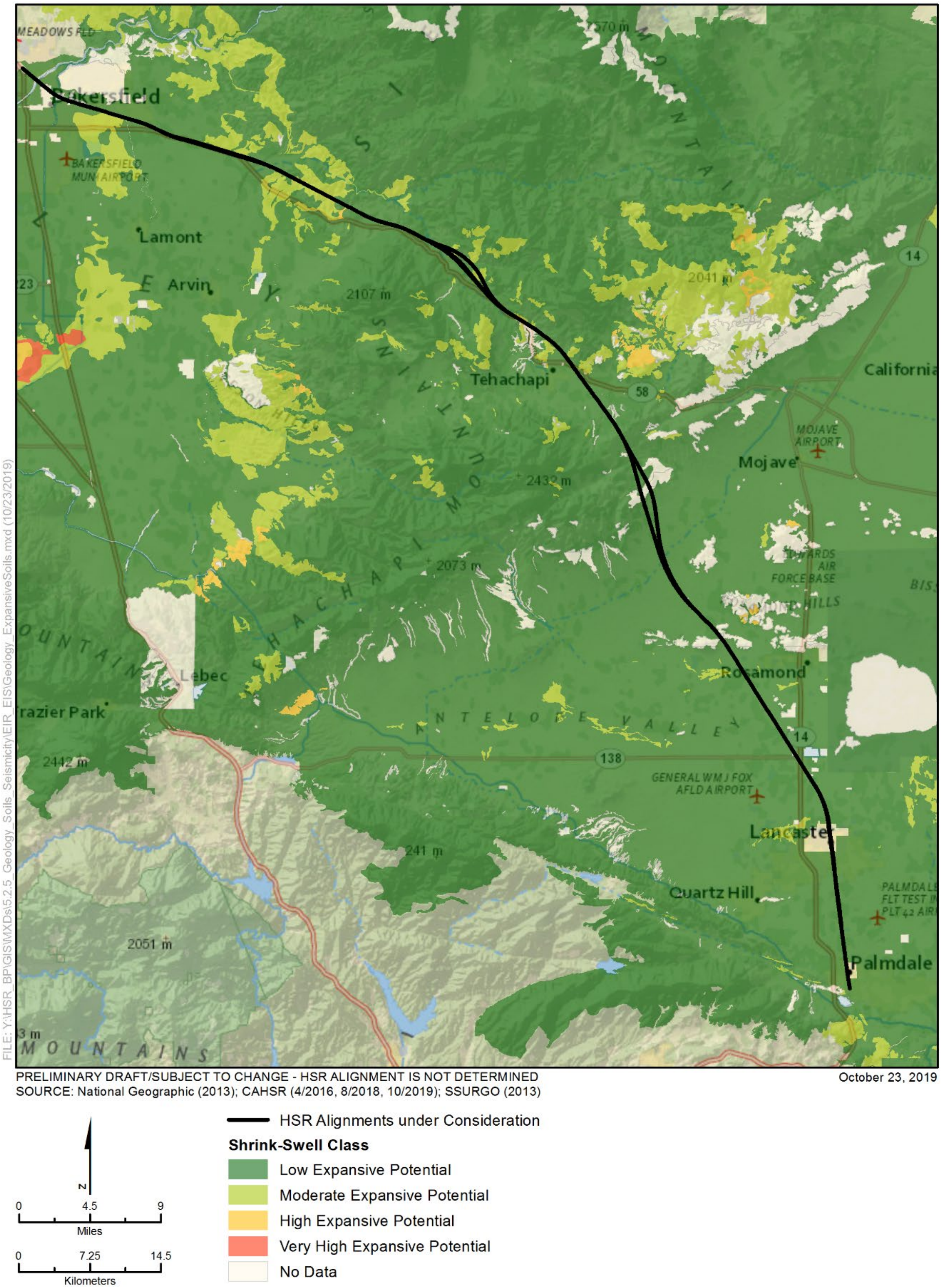


Figure 3.9-5 Expansive Soils in the Resource Study Area

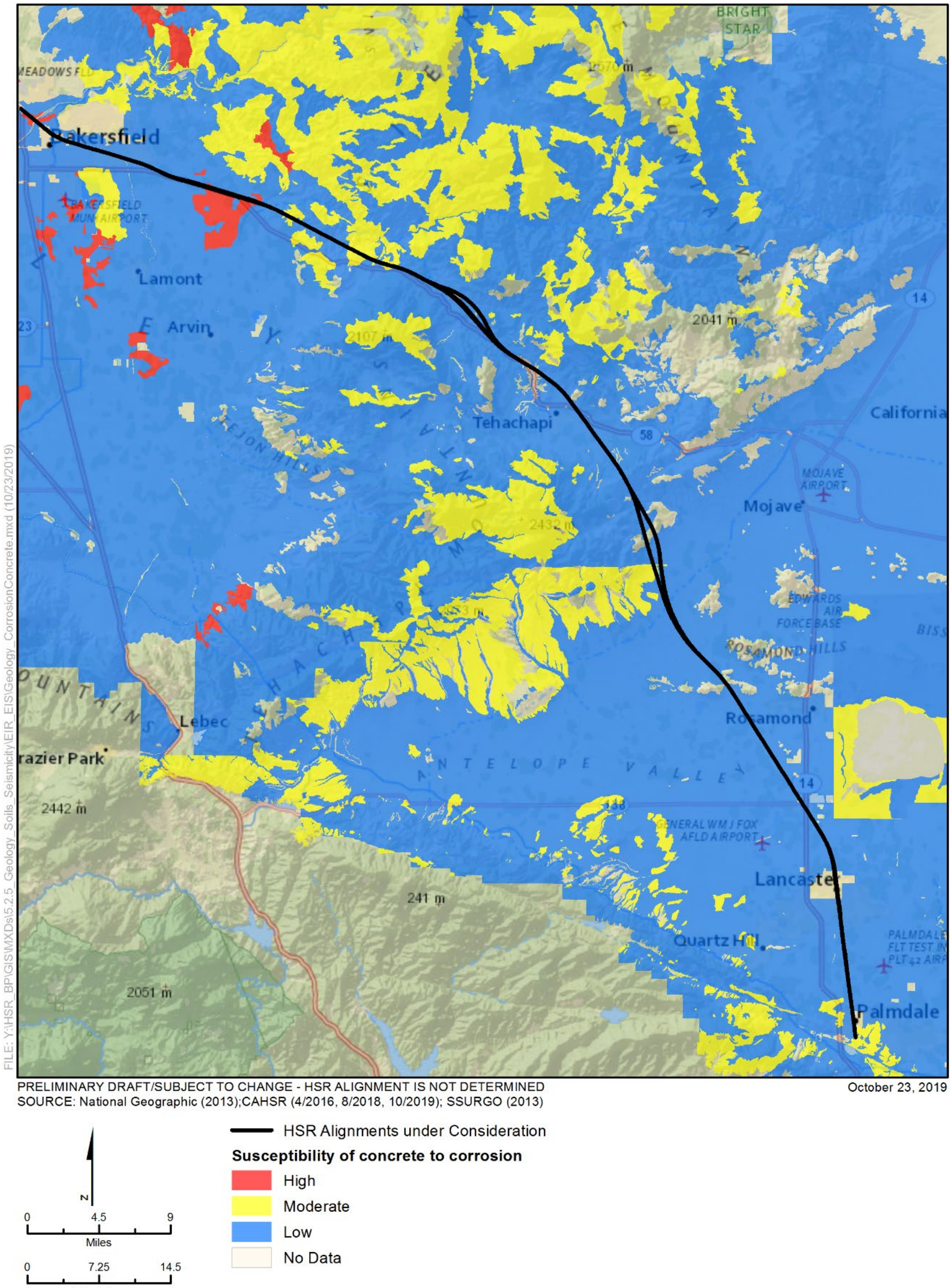


Figure 3.9-6 Soils Corrosive to Concrete

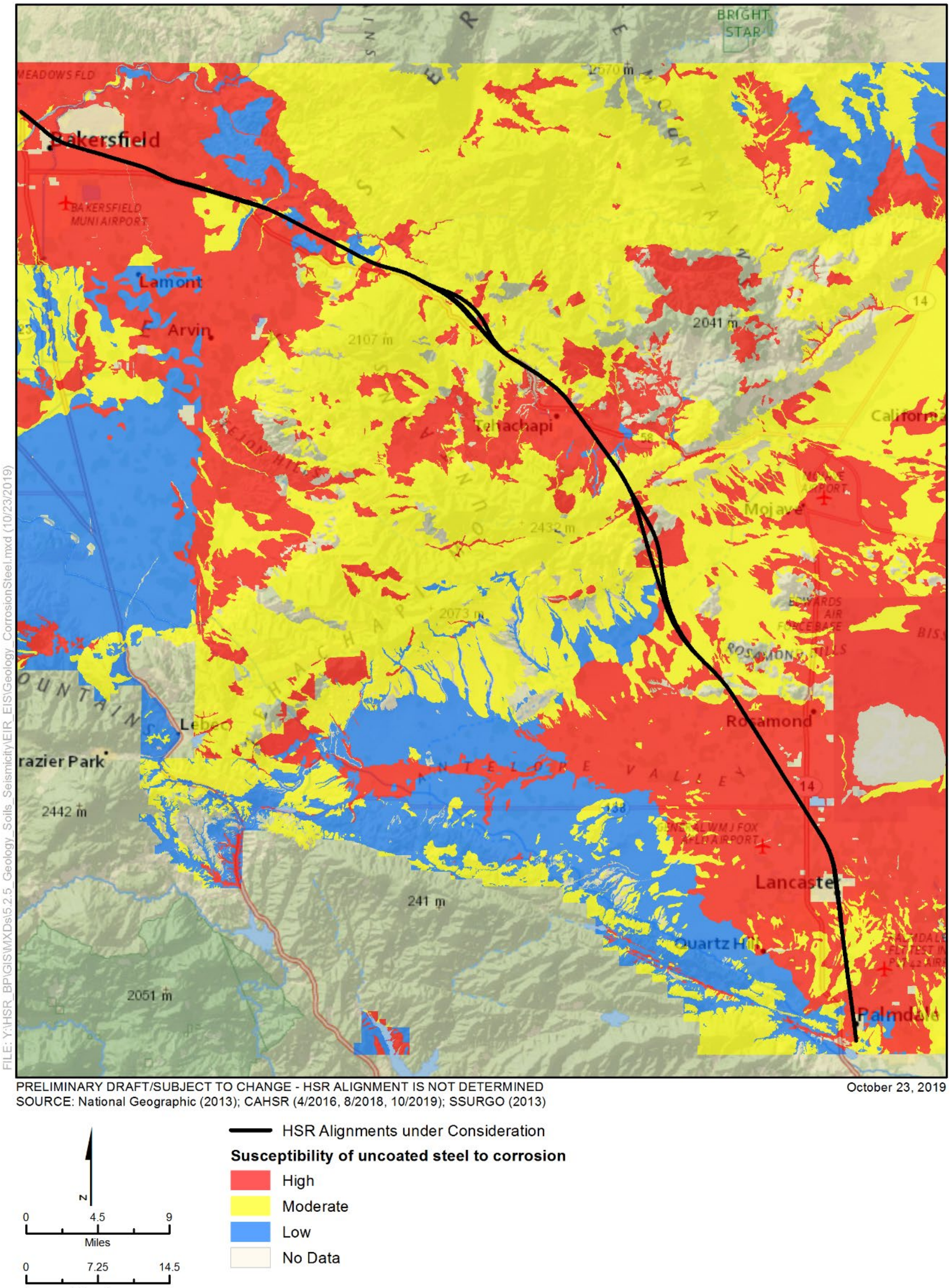


Figure 3.9-7 Soils Corrosive to Steel

Erodible Soils

Certain soil types demonstrate a higher potential for erosion by rainfall and runoff than other soil types. The Revised Universal Soil Loss Equation expresses this by a factor designated as "K," the soil erodibility factor. Figure 3.9-8 illustrates the relative soil erodibility factors along the length of the B-P Project Section. The Revised Universal Soil Loss Equation defines K 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 infiltrate water rapidly reduces surface runoff rates. Medium-textured soils, which are high in silt, have the greatest potential for erosion.

Figure 3.9-8 illustrates that the San Joaquin Valley and Tehachapi Mountains subsections generally have moderate soil-erodibility potential (K values from 0.25 to 0.40), while soils with low erosion potential (K values below 0.24) are dominant in the Antelope Valley. An area of moderately erodible soils is present east of the alignment in the Antelope Valley, near the west side of Rosamond Lake, but these soils do not extend to the project section.

Soils on steep slopes are often erodible, especially during heavy rain events. Some of the soils in the Tehachapi Mountains are on steep slopes and are considered moderately erodible, as illustrated on Figure 3.9-8. In addition, soils and alluvial deposits present in stream channels are susceptible to erosional scour, especially around foundation elements, where erosive forces can be concentrated.

Soft Compressible Soils

Localized soft soil layers consisting of highly plastic clay may occur within the alluvial deposits within the San Joaquin Valley subsection. Depending on the loading history of the soft soil, load-induced consolidation or downdrag on foundation piles may occur where new fills are planned.

Geologic Hazards

Nonseismic Hazards

The review of the affected environment considered two types of nonseismic geologic hazards for the B-P Build Alternatives, maintenance facilities, and stations: (1) slides or slumps along steep slopes located in the mountains and next to rivers and creeks; and (2) land subsidence. These geologic hazards pose potential threats to the health and safety of citizens.

Slides and Slumps

The San Joaquin Valley and Antelope Valley portions of the Mojave Desert are generally broad, alluvial plains that are relatively flat. The lack of significant slopes in the vicinity of these two subsections of the B-P Project Section indicates that the hazard from slope instability in the form of landslides or debris flows in the two valleys is low. However, the potential may exist for localized small slides and minor slumps where the B-P Build Alternatives cross steeper riverbanks and creeks.

Steeper slopes are present in the Tehachapi Mountains, within the Sierra Nevada subsection of the B-P Project Section. The Community Safety Element of the Tehachapi General Plan (City of Tehachapi 2012) indicates that the landslide hazard for slopes in and around the City of Tehachapi is considered low. Figure 3.9-9 illustrates landslides and steep slopes (30 percent or greater) along the B-P Project Section. The figure does not indicate any landslides along the B-P Project Section, although it shows most of the slopes within the Sierra Nevada subsection as steep. The Kern County General Plan considers slopes of 30 percent or greater to be steep and susceptible to hillside hazards.

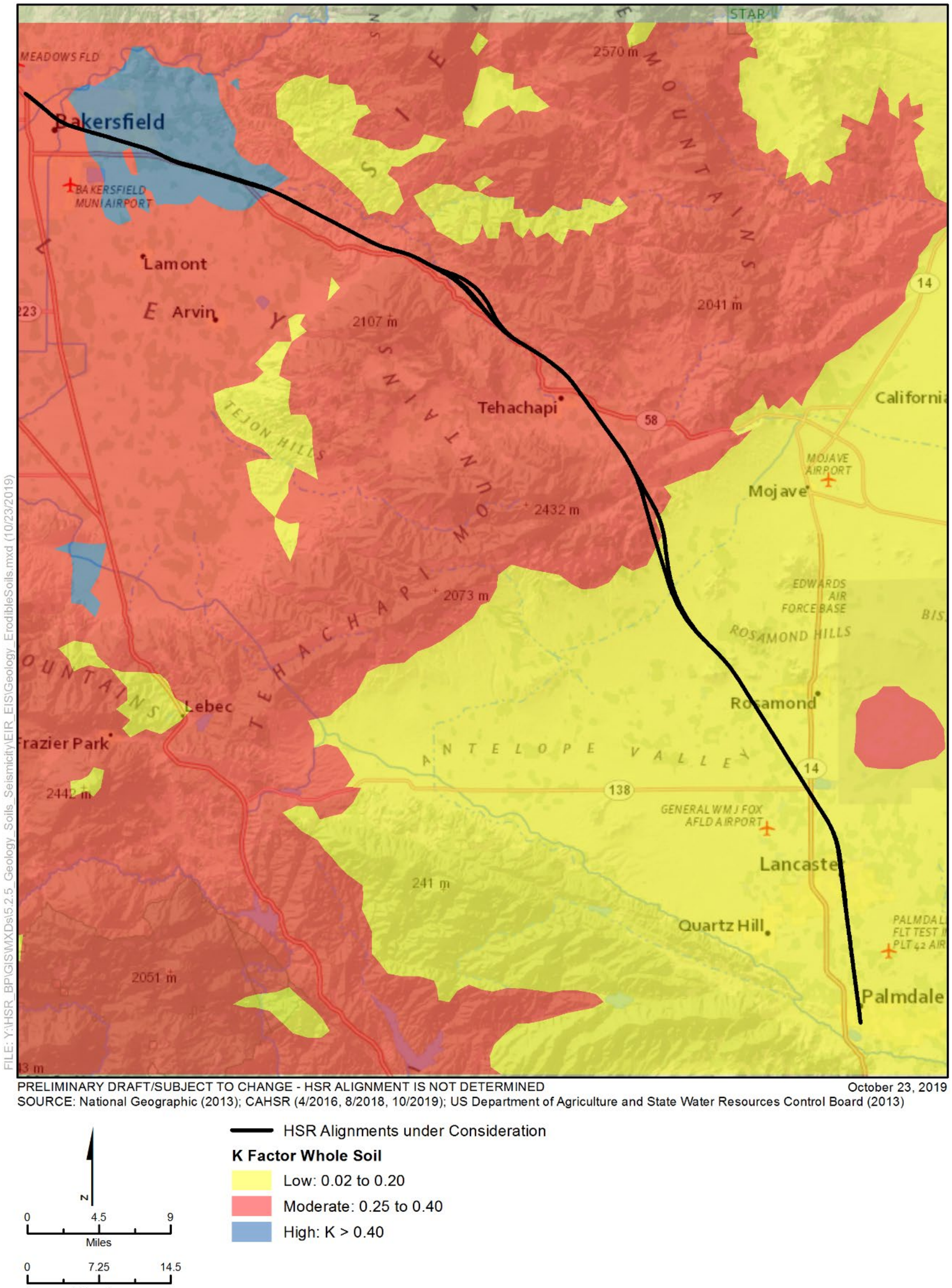


Figure 3.9-8 Erodible Soils

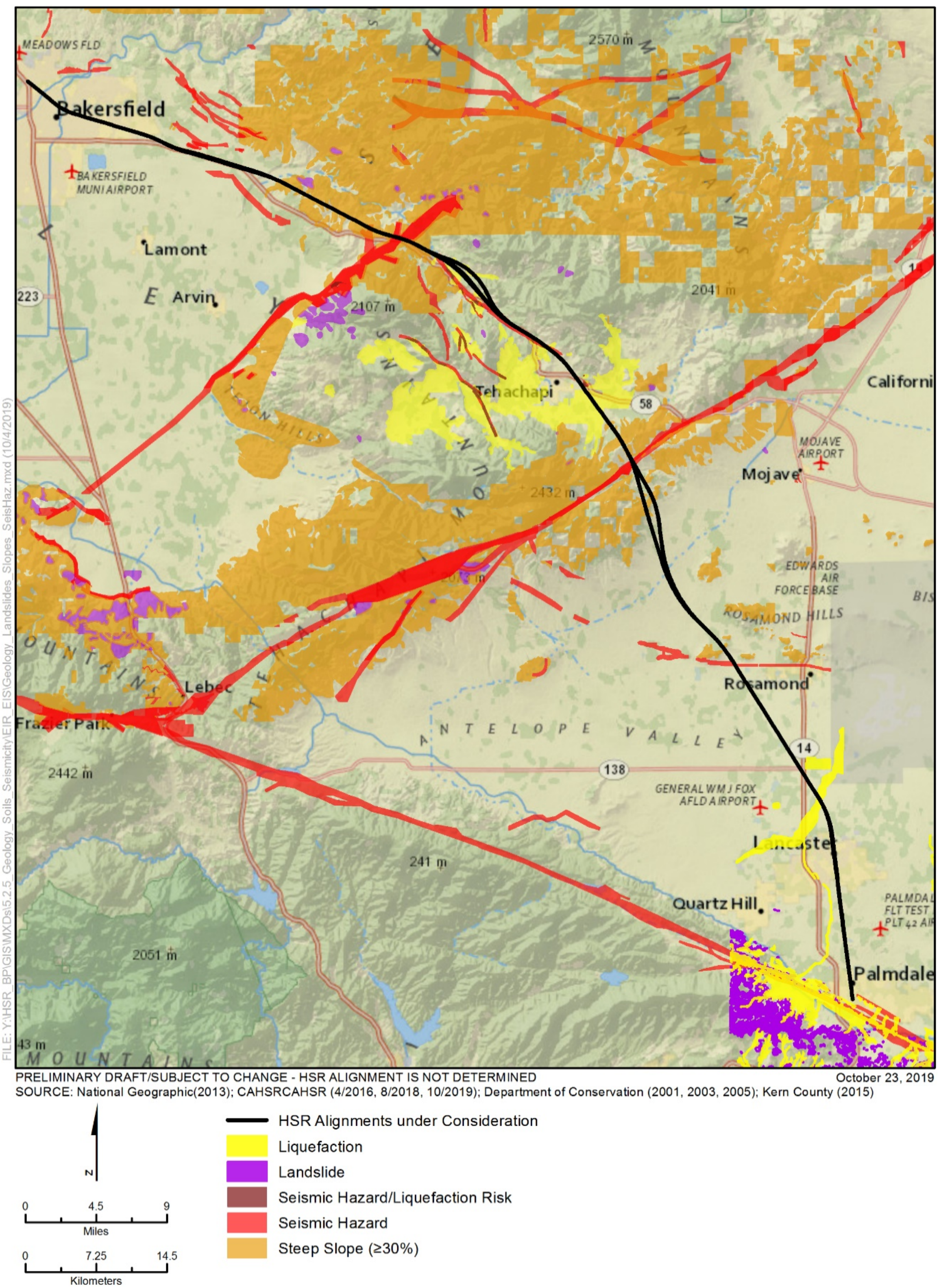


Figure 3.9-9 Landslides, Liquefaction, Seismic Hazards, and Steep Slopes

Land Subsidence

Both the San Joaquin Valley and Antelope Valley have a long history of land subsidence caused by the extraction of oil and gas, withdrawal of groundwater, and hydrocompaction of soils.

The Bakersfield to Palmdale Project Section traverses or is near areas experiencing subsidence. These areas include:

- **San Joaquin Valley**—Subsidence (Figure 3.9-10) occurs throughout the San Joaquin Valley north of Bakersfield, near Delano and Earlimart, and south of Bakersfield, between Arvin and Maricopa. The Arvin-Maricopa area contains a 700-square-mile area of subsidence located south of the alignment, caused by groundwater withdrawal (Lofgren 1975). Between 1926 and 1970, land in this area experienced up to 9 feet of subsidence. The B-P Project Section does not cross this area of subsidence, so subsidence is unlikely to affect HSR performance in this area.

  Oil field-related subsidence occurs in small areas to the south and west of Bakersfield. This type of subsidence has historically accounted for approximately 1 foot or less of oil-extraction-related subsidence in the Bakersfield vicinity and is localized in the area. Between August 1997 and September 1999, the National Aeronautics and Space Administration and the USGS monitored subsidence in the vicinity of Bakersfield using Interferometric Synthetic Aperture Radar. The Interferometric Synthetic Aperture Radar study has shown that up to 3.5 inches of subsidence occurred over a 2-year period in areas up to 12 miles to the north and northwest of Bakersfield. In addition, in the vicinity of the Edison Oil Field east of the proposed Bakersfield Station, subsidence due to oil production within the field may occur.

  Collapsible soils are known to exist within the San Joaquin Valley and could potentially lead to land subsidence. When irrigation water or rise in the groundwater table results in saturation of these soils, pores and voids between the soil particles disappear and the soils collapse. Soil sampling and laboratory testing are necessary to determine the potential risk of collapsible soils. If collapsible soils are present within the project footprint, it is possible to mitigate collapse potential by removing and recompacting (over-excavating) soils under optimum moisture conditions, pre-saturating foundation soils, and implementing improvements to post-development site drainage.

- **Antelope Valley**—Subsidence due to groundwater extraction has been well documented throughout the Antelope Valley. Since the 1930s, groundwater levels near the City of Lancaster have declined as much as 300 feet, and at Edwards Air Force Base, groundwater levels declined as much as 150 feet between 1915 and 1991. The extreme decline in groundwater levels has led to regional ground subsidence, locally as much as 6 feet near Lancaster. Figure 3.9-11 shows the Antelope Valley RSA and associated subsidence. The area to the north and east of Lancaster is of particular significance to the B-P Project Section. The USGS conducted a model of three future scenarios (status quo, redistribution of pumpage, and artificial recharge) in this area (USGS 2003). Each scenario indicates that subsidence will likely continue in the Antelope Valley in the future, with the areas of greatest concern essentially where there is currently the greatest subsidence.

  The Palmdale General Plan indicates an area of 0.9 to 1.3 feet of subsidence in the northern portion of the city (City of Palmdale City Council 1993). The general plan reports the greatest degree of subsidence in the vicinity of the City of Lancaster, which is underlain by the Lancaster subbasin of the Antelope Valley groundwater basin. USGS modeling has demonstrated subsidence throughout the majority of the basin; a maximum of 9.4 feet occurred in the central and eastern portions of the subbasin. Subsidence of the Lancaster subbasin area is likely to continue, although the rate varies depending on future rates of groundwater pumping and recharge (Siade 2014).

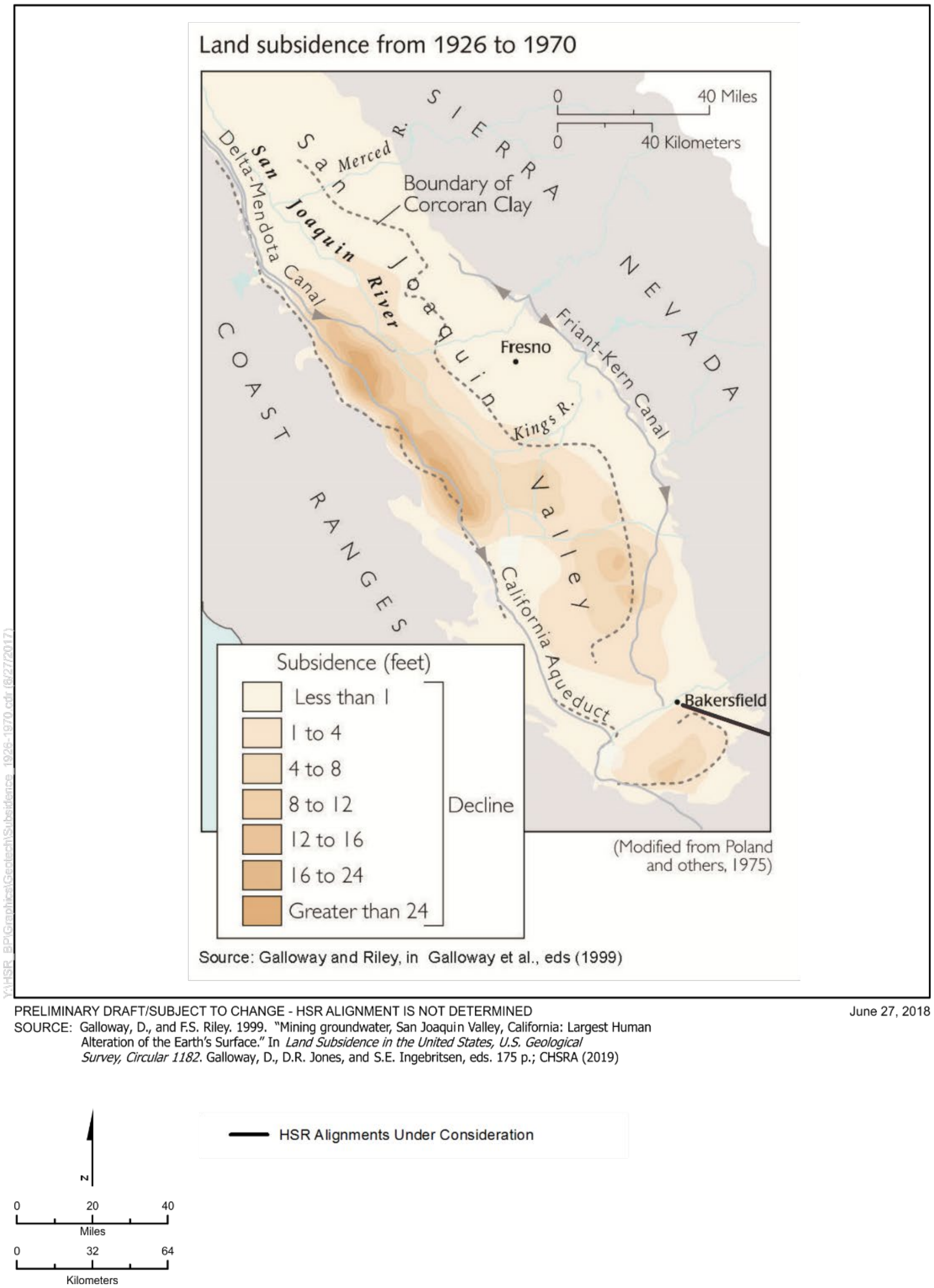
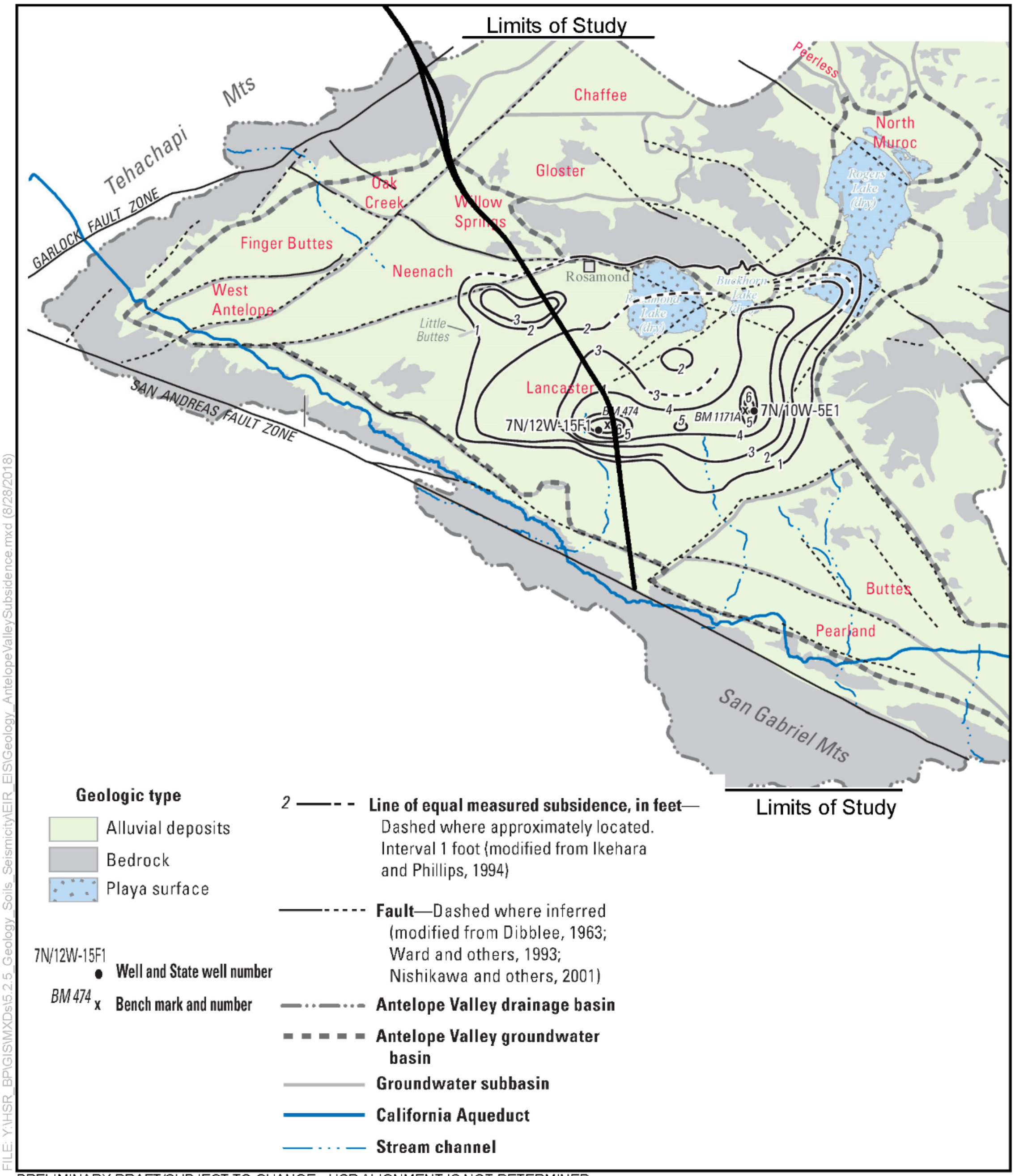


Figure 3.9-10 Subsidence in the San Joaquin Valley



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PRELIMINARY DRAFT/SUBJECT TO CHANGE - HSR ALIGNMENT IS NOT DETERMINED
SOURCE: National Geographic (2013); CHSRA (4/2016 and 8/2018); USGS SAIDE (2014)

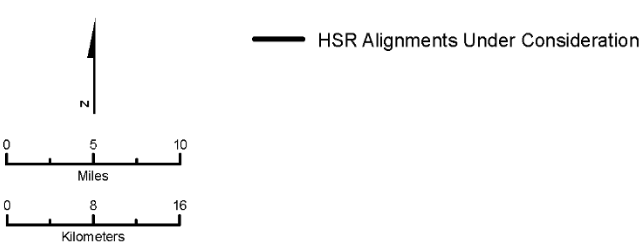


Figure 3.9-11 Subsidence in the Antelope Valley

Seismic Hazards

Primary Seismic Hazards

The primary seismic hazards assessed for the B-P Project Section are surface fault rupture along faults transecting the alignment and ground shaking. Both active and inactive faulting are prevalent throughout California. As discussed below, this analysis considers only hazardous and potentially hazardous faults. Figure 3.9-12 shows hazardous and potentially hazardous faults within approximately 62 miles of the B-P Build Alternatives. A seismic event along any of these faults, depending on type and exposure, can result in permanent offsets at the ground surface along the fault line and, depending on proximity to the event epicenter, varying degrees of ground shaking.

To reduce confusion concerning fault activity and avoid duplication of the terms “active” and “potentially active” (as codified in the text of the Alquist-Priolo Earthquake Fault Zoning Act), this document follows the nomenclature proposed by Technical Memoranda (TM) 2.9.3 and 2.10.6. These documents define fault activity levels as follows:

- **Hazardous Faults**—A fault that has (as documented in peer-reviewed reports) a greater than 1 millimeter per year (mm/yr) slip rate and a less than 1,000-year recurrence interval. The Alquist-Priolo Earthquake Fault Zoning Act designates this type of fault as “active.”
- **Potentially Hazardous Faults**—Those faults having known or documented Holocene activity or known Quaternary faults with suspected Holocene activity. The Alquist-Priolo Earthquake Fault Zoning Act designates this type of fault as “potentially active.”

Of the known hazardous fault zones that occur in the RSA, those that would pose the greatest hazard to the B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities are the San Andreas fault, the White Wolf fault, and the Garlock fault. Figure 3.9-12 depicts a portion of a California fault map. The San Andreas fault, at its closest, is 3.1 miles south of the B-P Project Section terminus. The alignment crosses the Alquist-Priolo Earthquake Fault Zones for the White Wolf and Garlock faults. These faults and the available data pertaining to them indicate that they could be the source of strong ground shaking for the two-county RSA included in the 62-mile radius. The type of fault the alignment would cross would determine the track grade and if whether it can be placed within a tunnel.

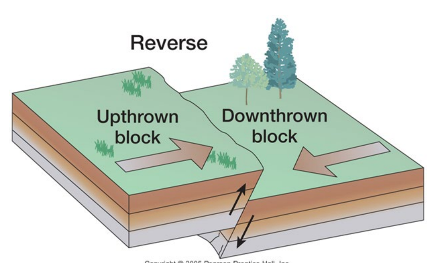
The review of information published by the USGS and CGS determined the following primary seismic hazards for the project.

Surface Fault Rupture

Surface fault rupture refers to the extension of a fault from depth to the ground surface with consequent displacement (e.g., vertical or horizontal offset). Surface fault ruptures are one result of stress relief during an earthquake event and often cause damage to structures located on the rupture zone. Hazardous faults within the RSA, including the White Wolf, Garlock, and San Andreas faults (Figure 3.9-12), have experienced surface rupture. The B-P Project Section crosses both the White Wolf and Garlock mapped faults but not the San Andreas fault. Therefore, the discussion below focuses on the White Wolf and Garlock faults.

Left-Lateral Reverse Fault

Inclined fractures where the blocks have mostly shifted vertically and the rock above the fault moves up.



The White Wolf fault is a northeast-trending, left-lateral reverse fault that last ruptured during the 1952 Kern County earthquakes. The fault extends from Wheeler Ridge, just west of Interstate 5, northeast almost to Fig Orchard, northeast of Bealville, for approximately 34 miles. The B-P Project Section would cross two segments of the White Wolf fault near Bealville Road just north of its intersection with SR 58 (Figure 3.9-12).

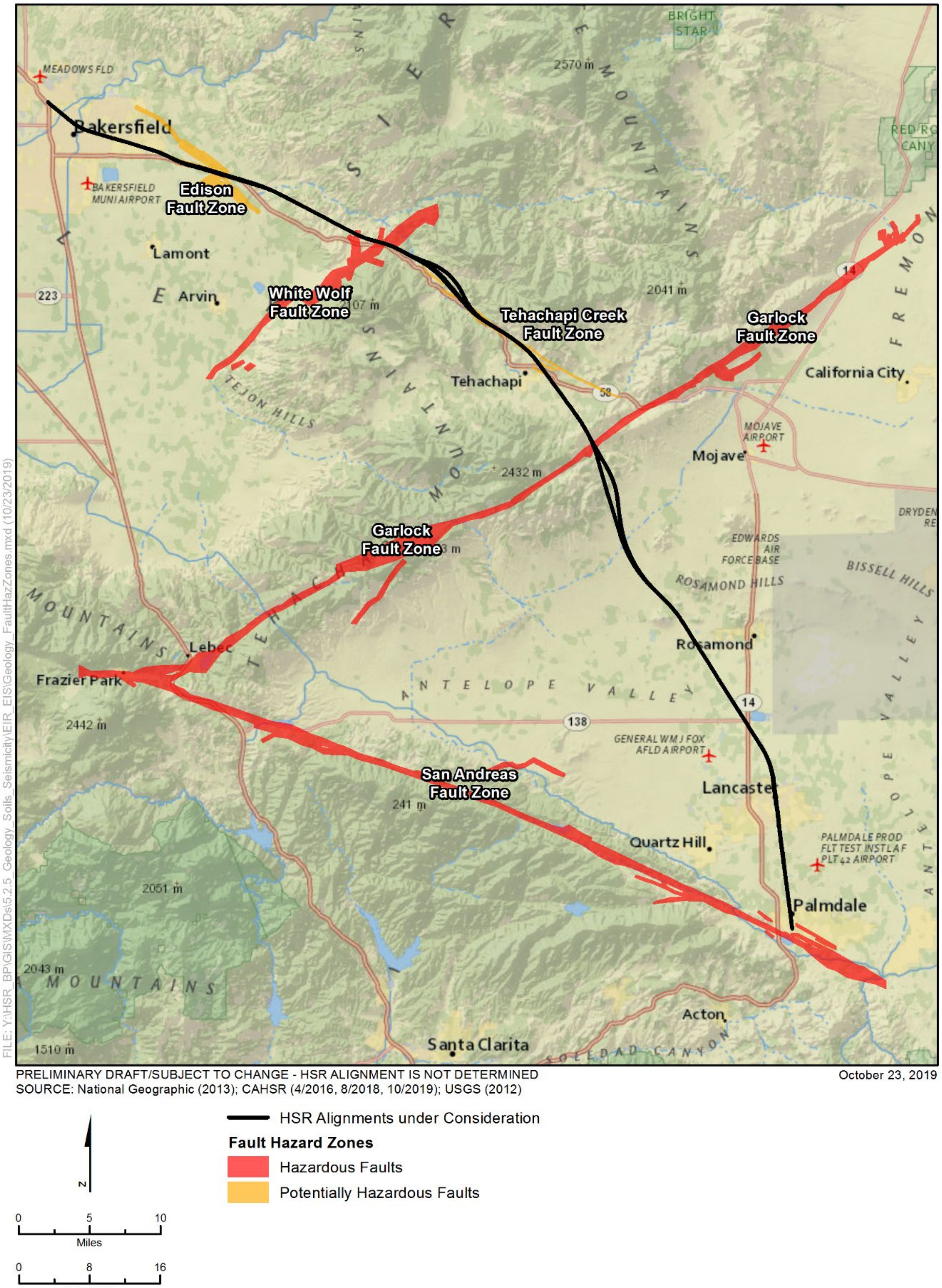


Figure 3.9-12 Fault Hazard Zones in the Resource Study Area

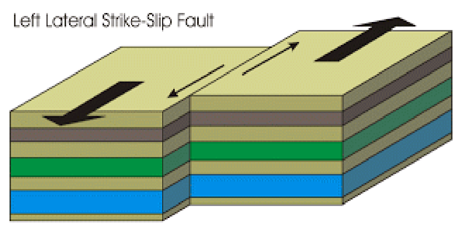
Where the B-P Project Section crosses the White Wolf fault Alquist-Priolo Earthquake Fault Zone just east of Bealville Road, the fault zone is approximately 2,820 feet wide and consists of several interconnected faults, generally trending in a northeast-to-southwest orientation. Another trace of the fault splits off from the main fault zone approximately 1 mile to the west of the B-P Project Section. The alignment crosses this fault trace 1.1 miles to the north of the main Alquist-Priolo Earthquake Fault Zone. This trace is approximately 1,150 feet wide at the location where the alignment crosses it. The White Wolf fault ruptured on July 21, 1952, with a magnitude of M7.5 to M7.7. Aftershocks, at least 20 of which were magnitude M5.0 or greater, followed this event for months. During the 1952 Kern County earthquakes, surficial ruptures formed along nearly the entire length of the fault, mostly on or near its previously mapped trace.

The recurrence interval and slip rate for the White Wolf fault are poorly defined. Stein (1981) estimated a recurrence interval of roughly 170 to 450 years for earthquakes with vertical displacements similar to that of the 1952 shock. Stein also found a rate of vertical displacement equal to 3 to 9 mm/yr for the late Quaternary, and after accounting for changes in the San Joaquin Valley, a 1 to 3 mm/yr rate of emergence above mean sea level for the hanging wall block in the late Quaternary. The 2007 USGS Working Group on California Earthquake Probabilities (Wills et al. 2008) assigned an estimated slip rate of 2 mm/yr to the White Wolf fault.

The Garlock fault is a near-vertical, left-lateral strike-slip fault that extends approximately 160 miles northeastward from its intersection with the San Andreas fault near Gorman to the intersection with the Death Valley fault system in the Avawatz Mountains. The B-P Project Section would cross the western segment of the Garlock fault approximately 0.8 mile northwest of the Oak Creek Road/Tehachapi Willow Springs Road intersection. The approximately 67-mile-long western segment of the Garlock fault extends from the intersection with the San Andreas fault near Frazier Park (about 34 miles southwest of the alignment) east-northeast to Koehn Lake, between SR 14 and U.S. Route 395 (about 33 miles northeast of the alignment).

Left-Lateral Strike-Slip Fault

Vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally and the block opposite an observer looking across the fault moves to the left.



While no historical large, surface-rupturing earthquake has occurred on the Garlock fault, paleoseismic studies have found clear evidence of Holocene surface-rupture earthquakes. The Garlock fault may rupture in its entirety or only segmentally. Unlike the central and eastern sections, the western section of the Garlock fault displays seismic creep (McGill and Sieh1991) and a higher level of seismic activity. The most recent earthquake on the western segment of the fault is estimated to have occurred between 890 years before present and 200 years before present (LaViolette 1981). Estimates of the recurrence interval for the Garlock fault range between 800 and 2,700 years (McGill 1994 and Madugo et al. 2012). Using the lower value for the recurrence interval (800 years), rupture on the western segment of the Garlock fault may be considered “probable” as defined in TM 2.10.6.

Previous research has assigned slip rates for the Garlock fault varying from 1.6 to 11.0 mm/yr. LaViolette (1981) calculated a minimum late Pleistocene slip rate of 1.6 to 3.3 mm/yr at an Oak Creek Canyon site. Clark and Lajoie (1974) and Clark et al. (1984) determined slip rates of 4.5 to 6.1 mm/yr and 5 to 8 mm/yr slip at Koehn Lake, near the boundary between the western and central sections of the Garlock fault. Estimated magnitudes for the Garlock fault range between magnitude M6.6 and M7.8. Astiz and Allen (1983) estimate a fault magnitude of M7.3 to M7.6, based on a slip rate of 7 mm/yr. McGill (1992) estimates a magnitude of M7.8 for rupture of the entire fault and M6.6 to M7.5 for rupture of smaller segments of the fault.

In July 2019, a sequence of earthquakes struck the Ridgecrest area, approximately 75 miles northeast of where the B-P Project Section would cross the Garlock fault. The Ridgecrest sequence included a 6.4M foreshock followed 34 hours later by a 7.1M mainshock. Over a

21-day period after the foreshock and mainshock, more than 111,000 earthquakes with magnitudes greater than 0.5, including 70 events with a magnitude greater than 4.0, occurred in Ridgecrest region (Ross 2019). The earthquake sequence occurred on largely unmapped faults that cumulatively extend more than 75 km (46.6 miles) in length north of the central portion of the Garlock fault (Ross 2019).

The B-P Project Section would also cross or come close to several potentially hazardous faults, including the Edison, Unnamed 1952, Tehachapi Creek, and Willow Springs-Rosamond Quaternary faults. The Edison and Unnamed 1952 faults have slip rates of less than 0.2 mm/yr. All of the potentially hazardous faults have a rather low level of activity, with slip rates of less than 1 mm/yr and recurrence intervals greater than 1,000 years. For a comprehensive discussion on surface fault rupture of the potentially hazardous faults, refer to the *Bakersfield to Palmdale Project Section Geology, Soils, and Seismicity Technical Report* (Authority 2016c).

Ground Shaking

The RSA is susceptible to strong ground shaking generated during earthquakes on nearby faults. Strong ground motion occurs as energy is released during an earthquake. The intensity of ground motion depends on the distance to the fault rupture, the earthquake magnitude, directivity effects, and the geologic conditions underlying and surrounding the site through which the seismic waves pass. Ground motions induced by a seismic event are typically characterized by a value of horizontal peak ground acceleration that is expressed as a percentage of the acceleration of gravity (g). Either deterministic or probabilistic methods are typically used to estimate the level of shaking that can be expected at a project site. The USGS has developed a probabilistic seismic hazard model for California (USGS 2014). Site-specific probabilistic estimates of ground motion corresponding to a 2 percent probability of exceedance in 50 years are available from the USGS (USGS 2014). Figure 3.9-13 shows historic earthquake activity in the region. Figure 3.9-14 presents the calculated peak ground accelerations for the B-P Project Section for this particular level of activity.

The highest ground accelerations (greater than 1.0 g) are anticipated in Palmdale at the San Andreas fault, with significant accelerations likely at the White Wolf and Garlock fault crossings.

Secondary Seismic Hazards

A number of secondary seismic hazards could occur in the RSA if there were strong ground shaking at the site. The strong ground shaking could result from either a nearby or distant earthquake, depending on the earthquake's magnitude, depth, and distance from the project.

These secondary hazards include liquefaction, seismically induced lateral spreading at select stream crossings, and floods resulting from seismically induced dam failure. The first two of these hazards occur primarily either where liquefiable soils exist or where steep slopes occur within the alignment alternatives or maintenance facilities. In contrast, the seismically induced floods could occur if any one of several dams located in the region fails, releasing impounded water that could eventually inundate the area.

Figure 3.9-9 indicates areas of high potential for liquefaction to occur in scattered locations in the Tehachapi Valley and near Lancaster. The Los Angeles County General Plan EIR (County of Los Angeles 2014) states that liquefaction zones within the county are generally concentrated within arroyos and washes that drain into the Mojave Desert. Groundwater is shallow and could create a liquefaction hazard along an approximately 2,000-foot section of where the project alignment crosses the Amargosa Creek channel south of the sewage treatment ponds and north of Lancaster (County of Los Angeles 2014). The *Bakersfield to Palmdale Project Section Hydrology and Water Resources Technical Report* (Authority 2018a) describes groundwater in greater detail.

Liquefaction could occur locally within saturated alluvial sediments along any of the many streams that cross the alignment. In areas where this is possible, site-specific evaluations would be necessary to evaluate the possible extent of liquefaction-induced deformation. None of the tunnels or tunnel portals for the B-P Project Section is in areas of potential liquefaction.

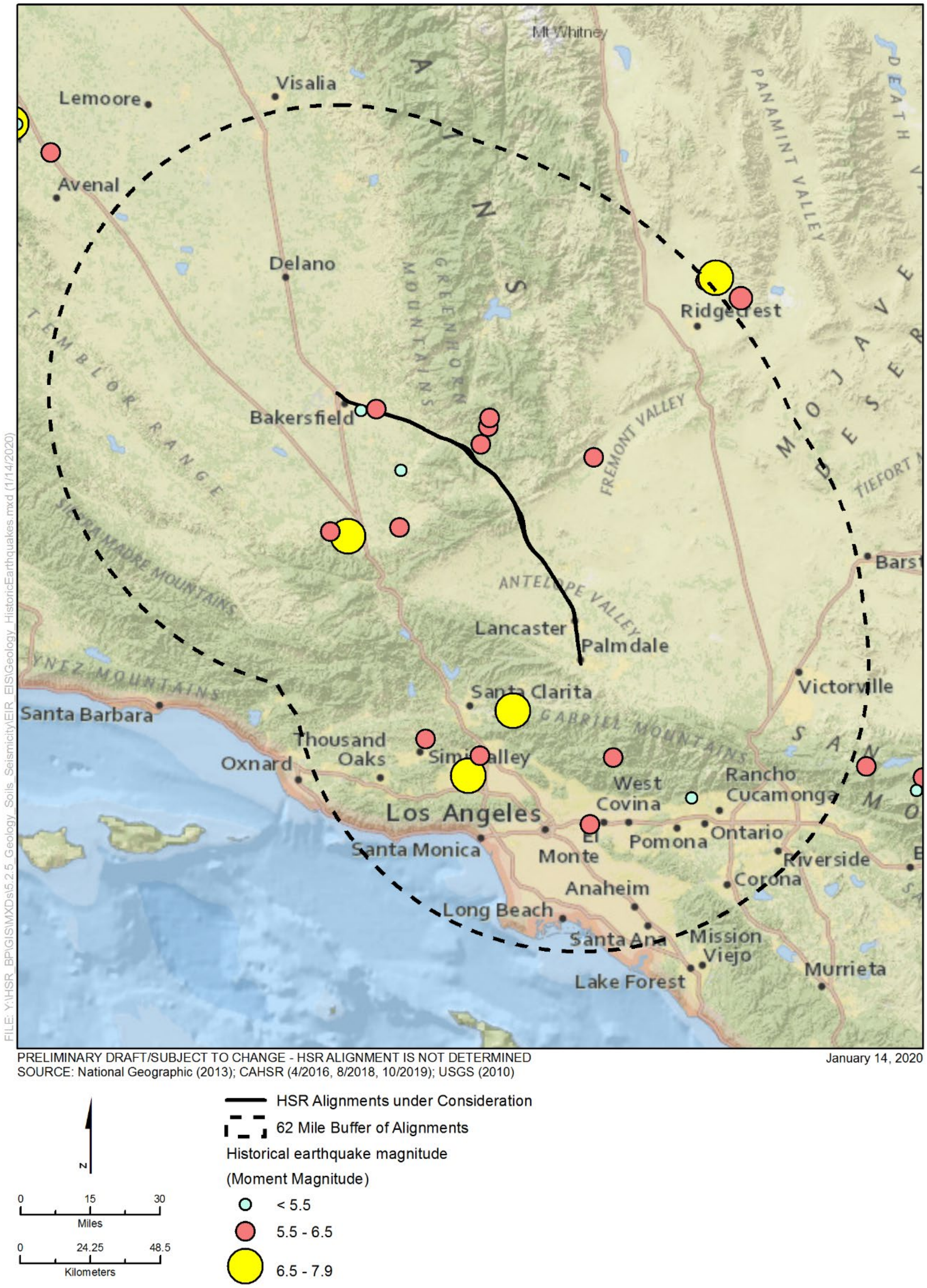
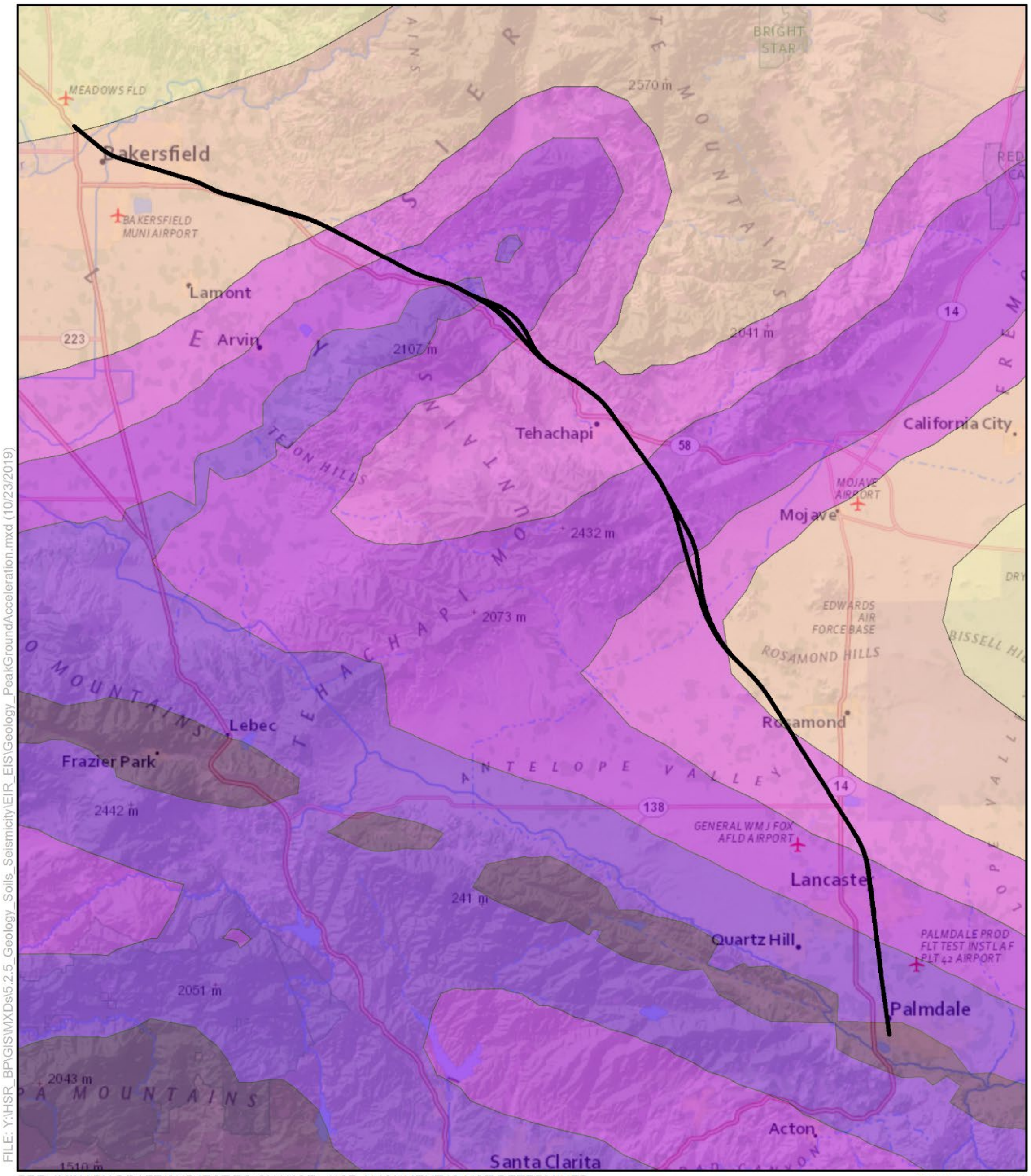


Figure 3.9-13 Historic Earthquakes and Magnitudes within 62 Miles of the Project Vicinity



PRELIMINARY DRAFT/SUBJECT TO CHANGE - HSR ALIGNMENT IS NOT DETERMINED
SOURCE: National Geographic (2013); CAHSR (4/2016, 8/2018, 10/2019)

October 23, 2019

N

0 5 10 Miles

0 8 16 Kilometers

HSR Alignments under Consideration

Peak horizontal acceleration, 2% in 50 years (%g)

- 30-40
- 40-50
- 50-60
- 60-80
- 80-120
- 120-160

Figure 3.9-14 Calculated Peak Ground Acceleration

One of the consequences of seismic liquefaction in sloping ground areas is the phenomenon known as lateral spreading, which refers to the translation of ground laterally after the loss of support due to liquefaction. For this to occur, the liquefied area must be relatively near a vertical or sloping face, such as a road cut or stream/river bank. The potentially liquefiable soils in the project section lie in relatively flat areas; therefore, lateral spreading in response to the liquefaction of subsurface soil is not likely. However, localized lateral spreading may occur in areas where the project section traverses or is close to creeks and river channels.

Earthquake-induced landslides have historically been a significant source of damage in California. Areas that are most susceptible to earthquake-induced landslides are steep slopes in poorly cemented or highly fractured rocks; areas underlain by loose, weak soils; and areas on or adjacent to existing landslide deposits. The potential for seismically induced landslides on the steeper slopes of the Tehachapi Mountains in the Sierra Nevada province is higher than in the relatively flat-lying areas in the vicinity of Bakersfield in the San Joaquin Valley province and in the Antelope Valley area of the Mojave Desert province.

The last type of secondary hazard involves water inundation resulting from the failure of dams. Failure of water-retaining structures such as dams, levees, or large storage tanks during a seismic event causes seismically induced flooding. Review of the California Emergency Management Agency's dam inundation maps shows that the northernmost portion of the Bakersfield to Palmdale Project Section of the HSR system is just within the limits of the potential inundation area of one reservoir, Lake Isabella. U.S. Army Corps of Engineers maps from 2008 show that failure of Lake Isabella Dam could result in inundation of the southernmost portion of the B-P Project Section by as much as 20 feet of water. Figure 3.9-15 shows the inundation areas relative to the B-P Project Section, and the discussion below describes them. The inundation areas shown are conservative scenarios, assuming that the retained bodies of water are at their maximum elevation and assuming catastrophic failure of the retaining structures during seismic shaking. Section 3.8, Hydrology and Water Resources, provides a more detailed discussion of potential flooding due to dam failure.

In late April 2006, the U.S. Army Corps of Engineers discovered seepage problems in the Isabella auxiliary dam. Upon this discovery, the U.S. Army Corps of Engineers reduced the allowable capacity of the reservoir to no more than 66 percent, a level deemed safe and within acceptable safety parameters. In 2010, consultants to the U.S. Army Corps of Engineers found evidence that the Kern Canyon fault beneath the Isabella auxiliary dam was active (URS et al. 2010).

Blackburn Dam, another small impoundment in the Tehachapi Valley, is 1.6 miles southwest of the B-P Project Section. The B-P Project Section crosses the inundation area for Blackburn Dam (California Office of Emergency Services 2015). In the event of a catastrophic dam failure, flows from Blackburn Dam would move east toward Proctor Lake. This dam is designed to withstand the maximum credible earthquake.

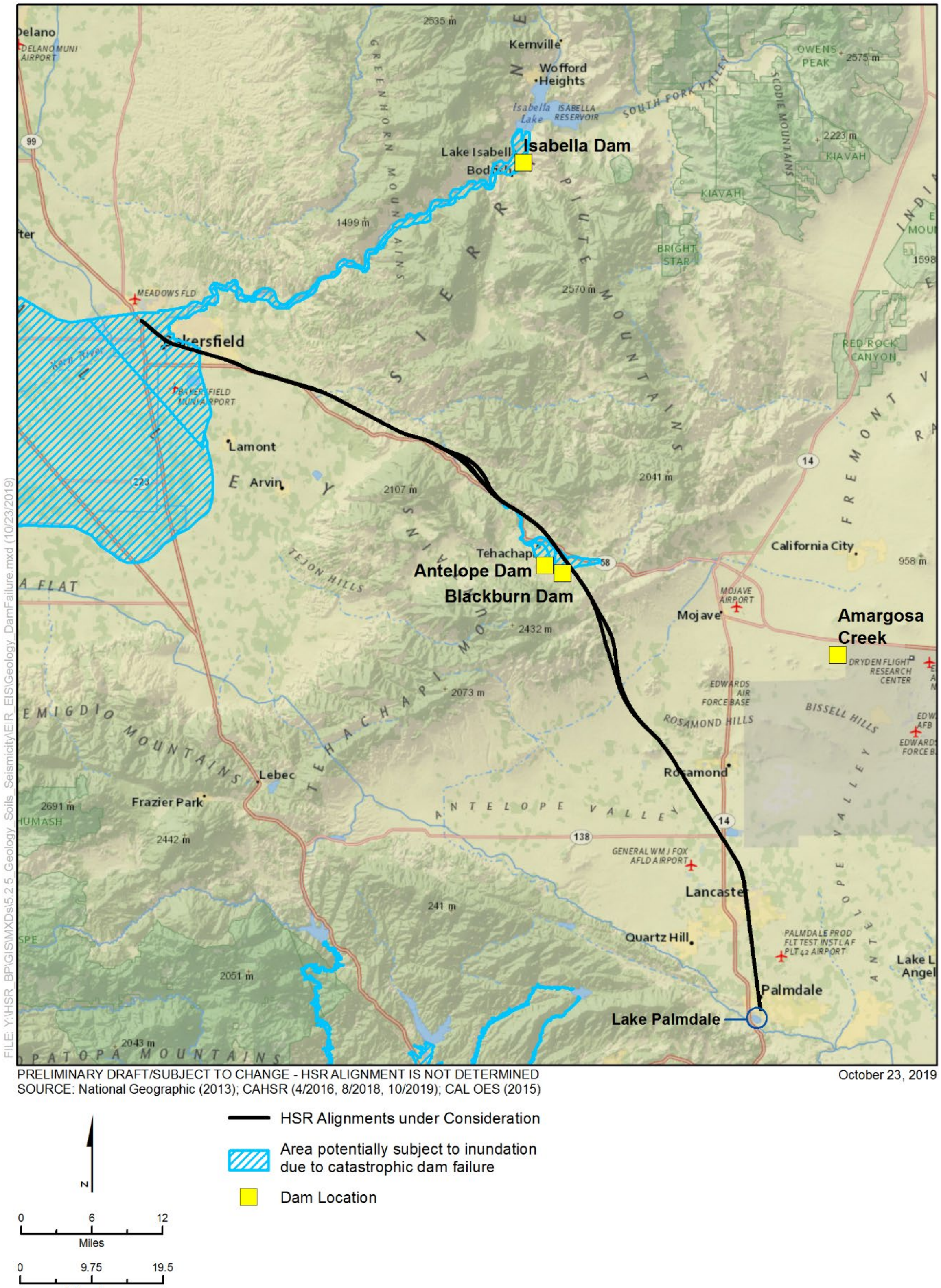


Figure 3.9-15 Inundation Areas in the Resource Study Area Due to Catastrophic Dam Failures

Areas of Difficult Excavation

Areas of difficult excavation are those requiring more than standard earthmoving 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. Excavation in these areas may require the use of a tunnel boring machine. The use of rippers and roadheaders would occur in weaker-strength rock or highly weathered and/or jointed rock masses.

The segment of the alignment in the Tehachapi Mountains may require deep cuts into bedrock in this steep terrain. The project design would use multiple tunnels, viaducts, and deep cuts to cross over or under rugged terrain, canyons, steep slopes, and mountain creeks. Throughout the Tehachapi Mountains, bedrock is generally shallow or at the ground surface, requiring the use of rippers and blasting to excavate. Permanent cuts to bedrock would generally extend to less than 200 feet in depth but a few areas would exceed 400 feet. The contractor would use rock coring equipment where overcrossings require drilled foundations. Drilling, blasting, and tunnel boring machines would also be required to create tunnels of lengths between approximately 1,500 and 12,000 feet.

Due to the presence of predominantly uncemented sediments in the Antelope Valley, areas of difficult excavation are not likely to be widespread. However, the project may encounter exposed or shallow bedrock comprising the Gem Hill Formation from Tehachapi Willow Springs Road, south of the intersection with Backus Road, to Rosamond Boulevard. In this area, the alignment is above existing grade and would only require remedial excavation to a few feet below the ground surface. Therefore, equipment beyond standard earthmoving equipment is not anticipated to be necessary. The subsection of the alignment in proximity to the Palmdale Station may also require the use of construction equipment not typically necessary for earthwork. Areas of hardpan and high excavation difficulty exist at the Palmdale Station between Technology Drive and W Palmdale Boulevard, east of Division Street. Construction in this region would require the use of rippers or rock core barrels.

Earthwork construction would occur in a manner to achieve a balanced condition where the quantity of soil or earthen materials removed through excavation would be roughly equal to the quantity of material being placed in embankments. The contractor would adjust the ratio of excavation to embankment to achieve this balance through use of variations in cut slope ratios, embankment widths, and embankment slope ratios during construction as existing ground conditions are revealed, and while maintaining the project limits within the proposed environmental footprint. The B-P Build Alternatives, the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities are not anticipated to require any export of excavated materials to off-site locations.

Mineral and Energy Resources

Minerals

Active mining operations in the San Joaquin, Tehachapi, and Antelope Valleys consist of sand and gravel, limestone (for cement production), and gold. Aggregate resources are the only known mineral resources present within the RSA, with the exception of the historical, inactive cinnabar mines located in the Tehachapi Mountains. Two construction aggregate mines exist along the B-P Project Section: Edison Sand Company and Shumaker Mine (Figure 3.9-3). Figure 3.9-3 shows several other aggregate mines within several miles of the alignment. The project does cross an area containing significant aggregate mineral resources in the vicinity of Caliente Creek. While the project would cross this region, it would not impede mining from occurring in the area surrounding the alignment.

Historically, cinnabar (mercury) mining occurred in the Tehachapi Mountains. A former cinnabar mine site and associated tailings are adjacent to the B-P Build Alternatives, 2 miles southeast of Keene and north of SR 58 (Central Sierra Environmental, LLC 2007). Mining at the site ceased in the early 1970s.

As shown on Figure 3.9-3, the Lehigh Southwest Cement Company operates a limestone quarry on the north side of the Tehachapi Valley, approximately 4.5 miles east of Tehachapi, which is classified as MRZ-2a (Koehler 1999). This quarry provides limestone for the cement plant that operates in nearby Monolith. On the south side of the Tehachapi Valley, the alignment would pass just west of the CalPortland Company limestone quarry in a 9,500-foot tunnel. The Authority would acquire legal rights to the property within a 220-foot exclusion zone around the B-P Build Alternatives' tunnel structures to provide a buffer from CalPortland Company drilling and blasting excavation activities.

In the Soledad Mountain area, gold mining is associated with early Miocene (24 to 16 million years ago) rhyolitic volcanic rocks. Soledad Mountain produced approximately $10 million in gold between 1894 and 1934. Currently, the main mines in this area are part of the Golden Queen Mining Company, which through exploratory drilling has identified remaining resources of about 807 thousand ounces of gold and 8.3 million ounces of silver at its Soledad Mountain project (Defilippi et al. 2015). The open-pit gold mine is currently using a cyanide heap leach and a Merrill-Crowe process to recover gold and silver from crushed agglomerated ore (Golden Queen Mining Company, 2019). The project is approximately 5 miles south of Mojave and approximately 7 miles from the B-P Project Section. Figure 3.9-3 shows the Soledad Mountain mine.

Energy

The B-P Project Section crosses the Edison Oil Field 3 to 6.5 miles east of the F Street Station. There are many active oil wells, as well as plugged and dry holes (Figure 3.9-16 and Figure 3.9-17).

There is a potential for off-gassing (the emittance of gas as the byproduct of a chemical process) from inactive or abandoned oil and gas wells in the Edison Oil Field. However, the alignment is not in a tunnel in this location and does not have any deep cuts in this section. Further investigation of the potential for off-gassing would occur during the Phase II fieldwork.

Portions of the B-P Build Alternatives may overlie radon deposits. Radon is a radioactive, colorless, odorless, tasteless, and potentially deadly gas that occurs through the decay of uranium and thorium. Radon can accumulate in the bottom levels of buildings constructed over certain types of crystalline geologic materials, such as granite, schist, and gneiss. Radon could therefore potentially represent a hazard to B-P Build Alternatives in the Tehachapi Mountains.

Review of the DOGGR California Geothermal Map (DOGGR 2002) and California Division of Mines and Geology Geothermal Resources Map (California Division of Mines and Geology 1980) shows that none of the alternative alignments is in or near a geothermal resource area as classified by the DOGGR. Additionally, no producing or abandoned geothermal wells or geothermal springs are located along the B-P Build Alternative alignments.

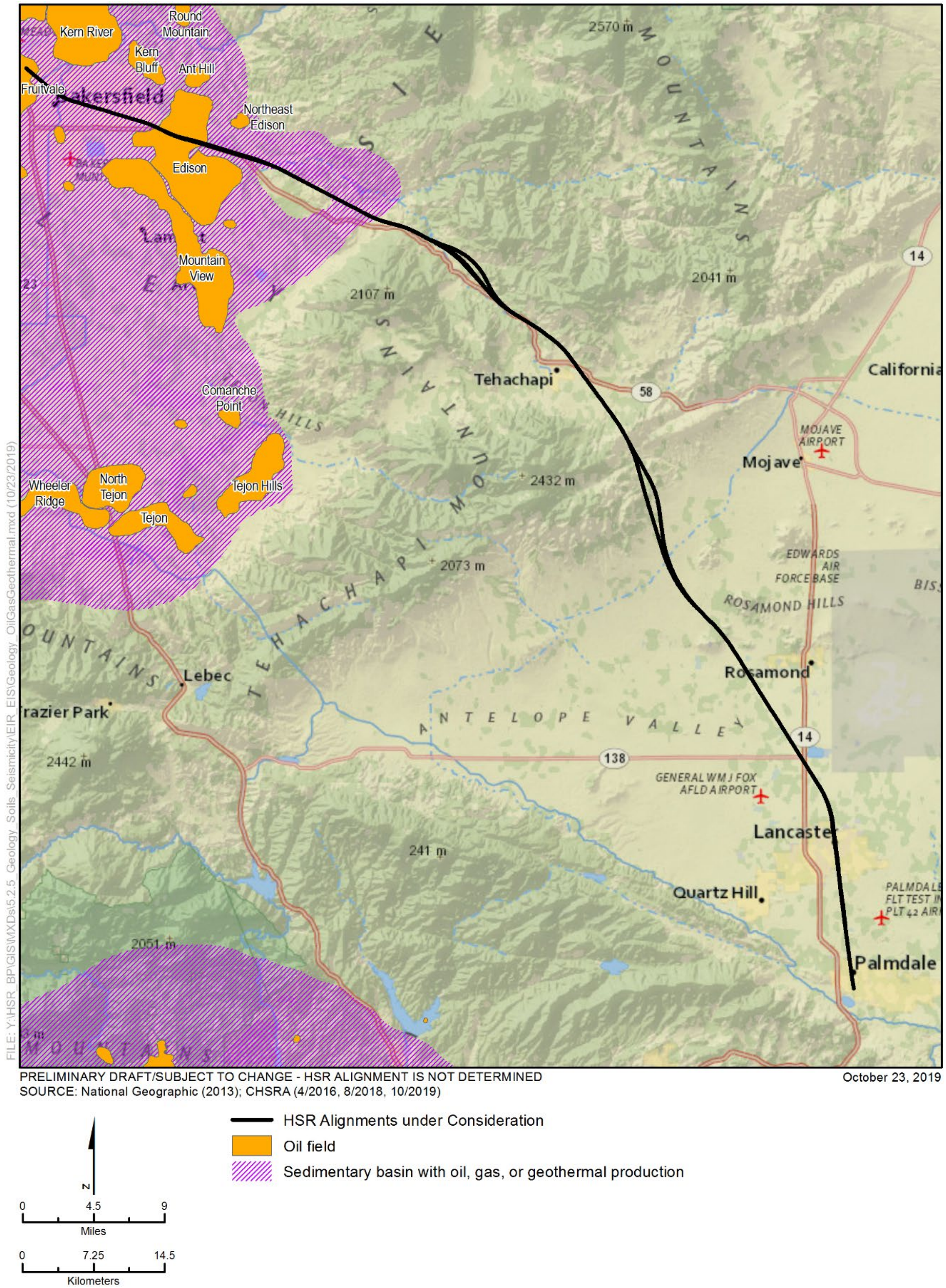


Figure 3.9-16 Oil, Gas, and Geothermal Fields

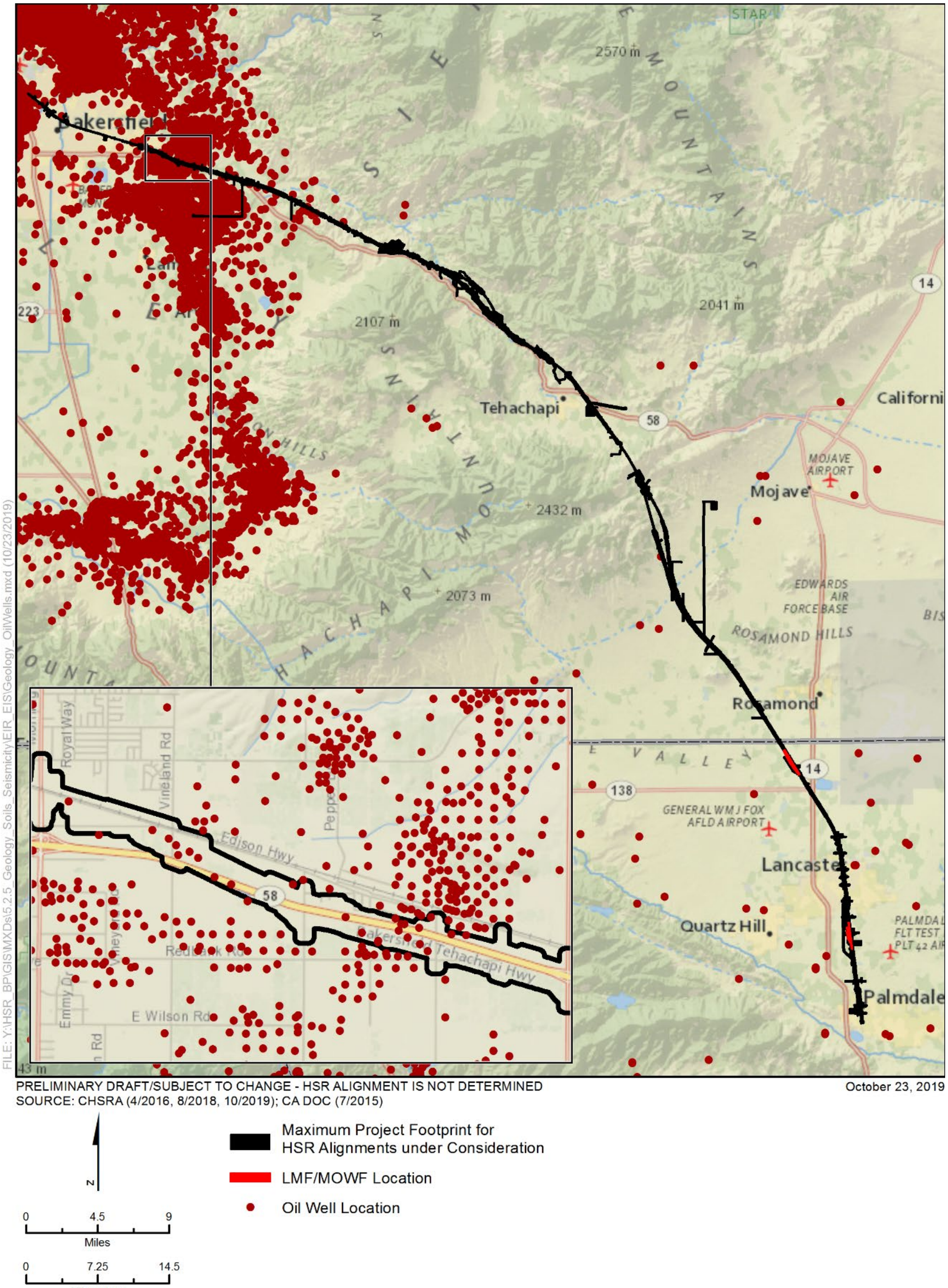


Figure 3.9-17 Oil Wells

3.9.5.4 Paleontological Resources

There are 12 geologic units mapped as underlying the RSA specific to paleontological resources at a 1:24,000 scale (Dibblee 2008a, 2008b, 2008c, 2008d, and 2008e; Dibblee and Louke 1970; Dibblee and Warne 1988; Haydon and Hayhurst 2011; Hernandez et al. 2010, 2013; Lancaster 2011; Olson and Hernandez 2013). They vary by fossil taxa,[5] paleontological significance, and density across their distributions. From youngest to oldest, these units include:

- Quaternary alluvium and other surficial deposits (Holocene)
- Quaternary older alluvium (middle to upper Pleistocene)
- Tehachapi Formation (Pliocene)
- Anaverde Formation (upper Miocene)
- Kern River Formation (upper Miocene)
- Unnamed Late Miocene volcanics (upper Miocene)
- Kinnick Formation (middle Miocene)
- Bena Gravel (middle Miocene)
- Gem Hill Formation (middle Miocene)
- Bealville Fanglomerate (lower Miocene)
- Unnamed Mesozoic plutonics, granitics, and dikes (Mesozoic)
- Kernville Series (Paleozoic: Carboniferous)

The literature review and museum archival search conducted for this inventory documented no previously recorded fossil sites in the RSA (Authority 2019). In addition, the August 2015 paleontological field survey recorded no fossil observations in the RSA. While there are no known fossil localities within the RSA, the literature reviews and museum archival records searches identified fossil localities within the greater geographic extent of the geologic unit, thereby informing the paleontological sensitivity evaluation.

As described in Section 3.9.4.3, this analysis evaluated the paleontological potentials of these units or layers using the Caltrans sensitivity ratings of high, low, and no potential for producing unique or scientifically significant fossils. The geologic units in the RSA and their criteria rankings are summarized in Table 3.9-5 and further described below. In Appendix 3.9-A, Figure 3.9-A-1, Sheets 1 through 13, show the geologic units in the RSA and Figure 3.9-A-2, Sheets 1 through 13, show the paleontological sensitivity of the RSA. Throughout the RSA, previously disturbed sediments (i.e., areas where grading or excavations have disturbed underlying geologic units) have no potential for producing unique or scientifically significant fossils and are not sensitive.

Quaternary (Holocene) Alluvium

Quaternary (Holocene) alluvial deposits (Qa, Qf, Qw) that are less than 5,000 years old (early Holocene) are too young to contain fossils and are considered to have no sensitivity for paleontological resources. However, early Holocene deposits (those deposits older than 5,000 years) can contain fossils and are considered to have high paleontological sensitivity. Geologic maps in the project area provide varying levels of detail regarding the ages of Holocene deposits at the surface (e.g., late, middle, or early Holocene), but almost no information is available in the literature (both primary and unpublished reports) regarding the thickness of Holocene sediments mapped at the surface. The lack of information regarding surface and subsurface ages of Holocene alluvium makes it impossible to determine with any certainty at what depth the potential to encounter scientifically significant fossils increases from low to high. In rare cases, such as a locality to the east of the RSA in the town of Rosamond, sediments mapped at the surface as Holocene-age (Dibblee 2008e) yielded Pleistocene-aged mammoth fossils at depths of less than 3 feet. Similarly, in the City of Tehachapi, sewer excavation in sediments mapped as Holocene yielded an isolated horse (*Equus* sp.) specimen.

[5] The plural of taxon; a formal grouping of organism populations into units (e.g., a species).

Table 3.9-5 Paleontological Sensitivity Evaluation of Geologic Units in the Resource Study Area

Geologic Unit	Unit Symbol(s)	Description	Paleontological Sensitivity[1]
Quaternary (Holocene) alluvium	Qa, Qf, Qw	Surface alluvium, clay, sand, and fanglomerate	Low (at surface), **High** (at depths below 5 feet)
Quaternary (Pleistocene) older alluvium	Qoa, Qof	Alluvium and fanglomerate	**High**
Tehachapi Formation	QTf	Cobble and boulder fanglomerate	Low
Anaverde Formation	Tas	Sandstone and shale	**High**
Kern River Formation	QTkr	Terrestrial clastic sediments	**High**
Unnamed Late Miocene volcanics	Tb, Td, Tf	Intrusive and extrusive volcanics	No
Kinnick Formation	Tk	Tuff and tuffaceous sandstone	Low
Bena Gravel	Tbe	Pebble and cobble gravels and sandstone	**High**
Gem Hill Formation	Tgba, Tgf, Tgo, Tgp, Tgt	Volcanics	No
Bealville Fanglomerate	Tbf	Boulder fanglomerate	No
Unnamed Mesozoic Plutonics, Granitics, and Dikes	aqd, db, g, h, hd, hqd, p, q, qd, qm	Granites, hornblende-biotite plutonics, and pegmatite-diabase dikes	No
Kernville Series	ml, mq, ms	Schist, marble, and quartzite	No

Sources: California Department of Transportation, 2012; Dibblee, 2008a–e
In Appendix 3.9-A, Figure 3.9-A-1 shows the geologic units in the RSA and Figure 3.9-A-2 shows the corresponding paleontological sensitivity.
[1] Based on California Department of Transportation Standard Environmental Reference sensitivity rating criteria of high, low, or no potential.
RSA = Resource Study Area

The thickness of Holocene sediments is inconsistent, variable, and unknown across much of the RSA, and shallow (i.e., less than 5 feet in depth) ground disturbance is typically unlikely to expose Pleistocene deposits. The depth at which underlying early Holocene and late Pleistocene sediments occur is variable; however, mapped Holocene units are generally considered to have low sensitivity at depths above 5 feet. Holocene deposits have low paleontological sensitivity at the surface and high paleontological sensitivity below 5 feet in depth.

Quaternary (Pleistocene) Older Alluvium

Quaternary (Pleistocene) older alluvium (Qoa, Qof) and Pleistocene alluvial deposits have yielded a large number of fossils in Southern California (Authority and FRA 2019). The University of California Museum of Paleontology, the Natural History Museum of Los Angeles County, and the San Bernardino County Museum contain fossils from Pleistocene units. These fossils include mammoth, camel, artiodactyls, rodents, rabbits, and reptiles. Based on the abundance of known fossil occurrences in Pleistocene sediments, these units are considered to have high paleontological sensitivity.

Tehachapi Formation

The Pliocene and possibly early Pleistocene rocks of the Tehachapi Formation consist of an assortment of cobble and boulder fanglomerate and sandstones. No fossils have been recovered from the Tehachapi Formation. Based on the age and composition (i.e., sandstone) of this formation, the preservation of paleontological resources is possible; however, the depositional environmental of the formation is unlikely to preserve fossil resources (Authority and FRA 2016). The Tehachapi Formation is considered to have low paleontological sensitivity.

Anaverde Formation

The fossil record of the Anaverde Formation includes well-preserved plant remains. Both plant remains in general and those fossils recovered from the Anaverde Formation are important for the study of ancient environments (Authority and FRA 2019). Fossils from this formation include plant leaf impressions representing flora that compose a host of communities, including live oak woodland, chaparral, coastal sage, grassland, desert border, and arid subtropical communities (Authority and FRA 2019). Two localities from the Antelope Valley have yielded terrestrial vertebrate fossils, including horse, bird, carnivore, rabbit, rodent, and mastodon. The Anaverde Formation is considered to have high paleontological sensitivity.

Kern River Formation

Only the lower part of the Kern River Formation has yielded fossils, but these fossils represent a relatively diverse vertebrate fauna that includes birds, artiodactyls, carnivores, rabbits, perissodactyls, and rodents (Authority and FRA 2019). Although vertebrate fossils are currently only known from the lower part of the formation, the upper part of the formation is similar in lithology and depositional setting, and fossils have the potential to be present throughout the formation. Based on its diverse known fossil record, the Kern River Formation is considered to have high paleontological sensitivity.

Unnamed Late Miocene Volcanics

Unnamed late Miocene volcanics (intrusive and extrusive; Tb, Td, Tf) represent a type of rock for which fossil preservation is extremely rare. Preservation occurs only in those cases where pyroclastic flows encase plants or animals or when ash fall events[6] cover plants and animals. Only a small handful of cases of this type of preservation are known in North America, and the late Miocene volcanics in the region of the RSA have yielded no fossils. As such, these mapped units are considered to have no paleontological sensitivity.

Kinnick Formation

The terrestrial pyroclastic rocks of the Kinnick Formation (Tk) are volcanic in origin. No fossils have been recorded from these units in the region of the RSA, and the units have almost no potential for yielding paleontological resources. The Kinnick Formation does include some terrestrial sedimentary units that could contain paleontological resources. The Kinnick Formation and the overlying Bopesta Formation typically co-occur in the Tehachapi Mountains. One hundred years of active geological and paleontological fieldwork (e.g., Buwalda 1916; Buwalda and Lewis 1955; Dibblee 2008a; Dibblee and Louke 1970; Hall 1930; Quinn 1987) have thus far yielded no fossils from the Kinnick Formation, while the Bopesta Formation has a relatively rich fossil record (Authority and FRA 2016). Based on the lack of recorded fossils and the depositional setting being only marginally suitable for fossil accumulation, the Kinnick Formation is considered to have low paleontological sensitivity.

Bena Gravel

The Bena Gravel (Tbe) have produced a small sample of taxonomically diverse fauna, including artiodactyls, carnivores, rabbits, perissodactyls, proboscideans (*Gomphotheriidae*), and rodents (Authority and FRA 2017). Based on this known paleontological record, the Bena Gravel is considered to have high paleontological sensitivity.

Gem Hill Formation

The Gem Hill Formation (Tgba, Tgf, Tgo, Tgp, and Tgt) consists of basalt, felsite, obsidian, perlite, and quartz, types of rocks that do not contain fossils. In addition, this formation has never

[6] Ash fall sediments are really a type of sedimentary rock of igneous origin, not an igneous rock.

yielded fossils. As such, these mapped units are considered to have no paleontological sensitivity.

Bealville Fanglomerate

The Bealville Fanglomerate (Tbf) has never yielded fossils. The depositional setting and lithology of the unit make it unlikely to contain paleontological resources. As such, this mapped unit is considered to have no paleontological sensitivity.

Unnamed Mesozoic Plutonics, Granitics, and Dikes

Unnamed Mesozoic plutonics, granitics, and dikes (aqd, db, g, h, hd, hqd, p, q, qd, and qm) are entirely intrusive igneous rocks that, by definition, cannot contain fossils and are considered to have no paleontological sensitivity.

Kernville Series

The metasedimentary rocks of the Kernville Series consist of metamorphic rocks that are very unlikely to contain fossils. Metamorphic rocks in general undergo temperature and pressure changes not conducive to fossil preservation. In rare situations where metamorphism was only partial and resulted from either temperature or pressures (but not both), preservation of nonvertebrate fossils may be present (Bernard et al. 2007). However, the Kernville Series contains mostly amphibolite-facies metamorphic rocks[7] (MacKevett 1960) and has never yielded fossils. Preservation of paleontological resources is unlikely to occur in these units. Thus, the Kernville Series is considered to have no paleontological sensitivity.

3.9.6 Environmental Consequences

3.9.6.1 Overview

This section evaluates how the No Project Alternative, the B-P Build Alternatives, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities could affect GSSPR. The impacts of the B-P Build Alternatives and the LMF/MOWF/MOIS facilities are described and organized as follows:

Geology, Soils, and Seismicity

- **Construction Impacts**
  - Impact GSS #1: Encountering Unstable Soils During Construction
  - Impact GSS #2: Soil Settlement at Structures or Along Trackway During Construction
  - Impact GSS #3: Soil Erosion During Construction
  - Impact GSS #4: Difficult Excavations Due to Bedrock and Hardpan During Construction
  - Impact GSS #5: Potential Exposure to Hazardous Gas During Construction
  - Impact GSS #6: Potential Encounters with Abandoned Mines During Construction
  - Impact GSS #7: Potential Exposure to Hazardous Minerals During Construction
- **Operations Impacts**
  - Impact GSS #8: Effects of Unstable Soils during Operations
  - Impact GSS #9: Effects of Soil Settlement during Operations
  - Impact GSS #10: Effects of Moderate to High Shrink-Swell Potential during Operations
  - Impact GSS #11: Effects of Moderately to Highly Corrosive Soils during Operations
  - Impact GSS #12: Effects of Slope Failure during Operations
  - Impact GSS #13: Effects of Seismicity during Operations

The B-P Build Alternatives, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities are in the San Joaquin Valley, the Tehachapi Mountains, and the Antelope Valley, which include rural areas in unincorporated Kern and Los Angeles Counties as well as urban areas in Bakersfield, Tehachapi, Lancaster, and Palmdale. Geology, soils, and seismicity risks exist within these areas. Construction and

[7] Amphibolite-facies metamorphism combines both medium and high temperatures and pressures.

operation of the B-P Build Alternatives, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities could result in changes to geology, soils, and seismicity risks, which could result in exposure to people and property, although impacts would be minimized through project design. The impacts of the project related to geology, soils, and seismicity are similar for all of the B-P Build Alternatives and the LMF/MOWF/MOIS facilities. Therefore, for the purposes of this analysis, the impacts would be the same for each B-P Build Alternative, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities.

Paleontological Resources

- **Construction Impacts**
  - Impact Paleo #1: Geologic Units Sensitive to Unknown Paleontological Resources During Construction

The B-P Build Alternatives and the LMF/MOWF/MOIS facilities are in the San Joaquin Valley, the Tehachapi Mountains, and the Antelope Valley, which include rural areas in unincorporated Kern and Los Angeles Counties as well as urban areas in Bakersfield, Tehachapi, Lancaster, and Palmdale. Paleontologically sensitive geologic units exist within these areas. Construction of the B-P Build Alternatives and the LMF/MOWF/MOIS facilities could result in the destruction of paleontological resources, although impacts would be minimized through project design.

3.9.6.2 No Project Alternative

Geology, Soils, and Seismicity

As discussed in Chapter 2, Alternatives, California Department of Finance projections indicate continued population growth in Kern and Los Angeles Counties. The No Project Alternative is based on existing conditions and on the funded and programmed transportation improvements and land use projects that are expected to be developed and in operation by 2040 (see Section 3.2, Transportation, and Section 3.19, Cumulative Impacts, of this Draft EIR/EIS). These projects are planned or approved to accommodate the projected growth for the RSA.

Infrastructure and development projects carry risks to public safety and create 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 capacity 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. The infrastructure and development projects that would be built regardless of the construction of the B-P Project Section would, at a minimum, be subject to the Title 24 Building Code requirements, which require application of engineering design features to address and minimize these risks.

Conversely, infrastructure and development projects that would be built regardless of the HSR alignment in the B-P Project Section 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 mineral resource or 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 ground shaking, surface fault rupture, 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 if such buildings are not upgraded to current standards.

Private and public entities would build projects, and these projects would be subject to the safety, building, and engineering requirements and standards of the federal, state, and local governments in which they occur. Foreseeable future transportation and development projects would be subject to environmental review under CEQA and/or NEPA, as applicable, and are anticipated to likely include implementation of appropriate IAMFs and mitigation measures as needed to avoid or minimize impacts associated with geologic hazards, unstable soils, and seismic hazards.

Paleontological Resources

Under the No Project Alternative, population growth-related land use conversions would likely affect paleontological resources in areas along the alignment alternatives over the next 20 to 30 years. These include associated changes in land uses and the development of other transportation infrastructure improvements. Impacts on paleontological resources could include damage or destruction of paleontological resources. If growth continues to spread beyond urban areas, converting farmland and other open areas to land uses like residential or commercial, these changes would likely result in further disturbance and possible damage to paleontological resources.

Foreseeable future transportation and development projects would be subject to environmental review under CEQA and/or NEPA, as applicable, and appropriate IAMFs and mitigation measures would likely be implemented as needed to avoid or minimize impacts associated with paleontological resources.

3.9.6.3 High-Speed Rail Build Alternatives

This section evaluates the direct and indirect impacts associated with GSSPR that would result from construction and operation of the B-P Project Section. The B-P Build Alternatives include tracks, stations, and the LMF/MOWF/MOIS facilities unless otherwise noted. This analysis assesses impacts after consideration of the IAMFs listed in Section 3.9.4.2.

Fresno to Bakersfield Locally Generated Alternative from the Intersection of 34th Street and L Street to Oswell Street

The GSSPR impacts for the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street are addressed in Section 3.9.4 of the *Fresno to Bakersfield Section Draft Supplemental EIR/EIS* (Authority and FRA 2017). However, the analysis within Section 3.9.6.3 of this Draft EIR/EIS also reflects the portion of the F-B LGA between the intersection of 34th Street and L Street to Oswell Street in Bakersfield.

Construction Impacts

Geology, Soils, and Seismicity

The potential impacts on construction relative to geology, soils, and seismicity include localized deposits of low-strength soils (unstable soils), areas with potential for soil settlement, and soil erosion and corrosive soils. The soil-related risks during construction are in areas generally located near streams and river crossings, where soils tend to be softer and groundwater is often closer to the ground surface, or in areas with perched groundwater conditions, where groundwater is nearer to the ground surface.

Impact GSS #1—Encountering Unstable Soils During Construction

Unstable soils consist of loose or soft deposits of sands, silts, and clays that are not adequate to support the planned structure loads. These soils exhibit low shear strength and, when loaded, can fail through bearing failures or slope instabilities. Unstable soils can occur on a localized basis, particularly near river and stream crossings. Section 3.8, Hydrology and Water Resources, lists and discusses stream crossings and proximity to streams for each B-P Build Alternatives and the LMF/MOWF/MOIS facilities.

Construction of the project on soft or loose soils could result in on-site or off-site slumps, small landslides at stream crossings, or instability of cut-and-fill slopes necessary for the B-P Build Alternative tracks. These potential slumps and landslides could endanger people or on-site or off-site properties if not addressed. Although this risk would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of construction relative to the frequency of large earthquakes. If an earthquake were to occur during construction, potential impacts could range from no impact to the potential for partially built structures or slopes to fail. This 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.

Construction impacts associated with unstable soils would be the same for all B-P Build Alternative alignments, the Palmdale Station, and the LMF/MOWF/MOIS facilities. The methods described in GEO-IAMF#1 address impacts from potentially unstable soils. Prior to construction, the contractor would prepare a construction management plan to address, in part, the minimization of geological constraints related to unstable soils during construction. Methods to minimize impacts from unstable soils include excavation and replacement with competent soils, pre-loading in combination with pre-fabricated vertical drains and stage construction, and ground improvement methods such as stone columns, cement deep-soil-mixing, or jet-grouting. The project would also include site-specific geotechnical investigations (e.g., soil classification, expansive soil, ground-water table depth testing) addressing unstable soils in accordance with Section 1802 of the IBC.

CEQA Conclusion

All B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities could be on soil that is unstable or could become unstable as a result of project implementation. GEO-IAMF#1 and GEO-IAMF#10, appropriate design standards (such as Section 1805.3 of the IBC), and standard safety practices would be implemented during construction to reduce potential impacts from unstable soils. Such techniques would be implemented to reduce the potential for on- or off-site landslides, lateral spreading, subsistence, liquefaction, or collapse if the project is located on unstable soil. With implementation of the IAMFs and appropriate design standards, impacts would be less than significant under CEQA during construction. Therefore, CEQA does not require any mitigation.

Impact GSS #2—Soil Settlement at Structures or Along Trackway During Construction

Soil settlement could occur during project construction 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. Settlement could also occur on a local scale at locations where soft deposits of silty or clay soils are subjected to new earth loads, as might occur with approach fills for elevated guideways, retained fill, or track subgrade and ballast materials placed to meet track grade requirements. A number of locations along the project footprint would require new earth fills. Settlement-prone (loose or soft) soils may potentially underlie some of these areas.

Although soils along the alignments are generally competent (medium-dense, stiff, or better), localized deposits of soft or loose soils could occur at various locations, particularly at water crossings, where soft or loose soils appear to be more prevalent. In some locations, settlement associated with project construction could also affect nearby existing structures or buried utilities located close to the area of construction. This impact would result from either new structures or earth fills (including retained fills) placed in areas underlain by settlement-prone (loose or soft) soils, or from dewatering excavations for below-grade sections of track where shallow groundwater occurs and soils are loose or soft. Soil settlement could also occur during construction of the project due to regional subsidence.

Pre-construction and construction investigations would identify specific settlement-prone locations, and the project would use engineered solutions for site-specific conditions. The IAMFs listed in Section 3.9.4.2 and described in detail in Appendix 2-E outline these solutions. Where subsurface conditions may not be capable of supporting the additional loading induced by additional fill, the project could incorporate engineering design features that address soft deposits of silty or clay soils, such as pre-loading to accelerate settlement or adding wick drains if applicable. Additionally, the localized use of well points for dewatering, or sheet piling to preclude lowering the groundwater table in sensitive areas, could minimize the potential for the HSR improvements to affect existing structures or utilities. Preparation of a construction management plan addressing how the contractor would address specific geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would minimize risks associated with soil settlement.

CEQA Conclusion

All B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities could be developed on soils that have settlement potential. With implementation of the above-stated IAMFs, the impact from soil settlement at structures or along the trackway during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #3—Soil Erosion During Construction

Accelerated soil erosion, including loss of topsoil, could occur as a result of project construction. As previously shown on Figure 3.9-8 and discussed in Section 3.9.4, there are areas particularly susceptible to soil erosion near Bakersfield, and there are some moderately erodible soils in the Tehachapi Mountains.

Table 3.9-6 shows the total acreage of soils with moderate or high erosion potential that could be affected during construction. B-P Build Alternative 3 would affect the largest area of soils with moderate erosion potential (3.656.9 acres) during construction, and B-P Build Alternatives 1 and 5 would affect the smallest area (3,553.4 acres). B-P Build Alternative 2 would affect 3,556.9 acres of soils with moderate erosion potential during construction. The CCNM Design Option would affect 3.6 more acres of soils with moderate erosion potential during construction for each B-P Build Alternative. The Refined CCNM Design Option would affect 701.8 more acres of soils with moderate erosion potential during construction for each B-P Build Alternative. The LMF/MOWF/MOIS facilities under B-P Build Alternative 2 would affect 25.7 more acres of soils with moderate erosion potential. Implementation of B-P Build Alternatives 1, 3 and 5 would affect 30.8 more acres of soils with moderate erosion potential during construction. All of the B-P Build Alternatives except B-P Build Alternative 2 would affect 1,015.3 acres of soils with high erosion potential. B-P Build Alternative 2 would affect 945.7 acres, which is the smallest area of all the B-P Build Alternatives.

Table 3.9-6 Soils with Moderate and High Erosion Potential Disturbed during Construction (acres)

Soil Erosion Potential	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/MOIS Facilities
Moderate Erosion Potential	3,553.4	3,556.9	3,656.9	3,553.4	+3.6	+701.8	+25.7 (Alt. 2) +30.8 (Alts. 1, 3, 5)
High Erosion Potential	1,015.3	945.7	1,015.3	1,015.3	No change	No change	No change
Total	**4,568.7**	**4,502.6**	**4,672.2**	**4,568.7**	**+3.6**	**+701.8**	**+25.7 or +30.8**

Source: Soil data from United States Department of Agriculture, 2013

Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

CCNM = César E. Chávez National Monument

LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility

With the development of any B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities, the potential for more surface water runoff exists when construction results in the removal of existing vegetation and the increased exposure of unprotected soils to both wind and water erosion. If exposed soils are not protected from wind or water erosion, both the exposed work area and any stockpiles could erode and cause indirect impacts on air and water quality. Increased surface water runoff could also result from the construction of temporary, impermeable work surfaces.

Project construction would include implementation of 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 (BMP) Field Manual and Troubleshooting Guide* (Caltrans 2003a), in order to reduce the potential for erosion. HYD-IAMF#3 requires contractors to prepare a construction-period Stormwater Pollution Prevention Plan, which will provide BMPs to minimize potential short-term increases in sediment transport caused by construction. GEO-IAMF#10 outlines additional guidelines and standards. GEO-IAMF#1b describes specific methods to address soil erosion, including the use of mulches, revegetation, and covering areas with geotextiles. Preparation of a construction management plan addressing 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 soil erosion.

CEQA Conclusion

During construction of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities, soil erosion could occur from construction activities. BMPs would be implemented during construction to ensure soil erosion is reduced. With implementation of the above-stated IAMFs, the impact from soil erosion during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #4—Difficult Excavations Due to Bedrock and Hardpan During Construction

Upper layers of soil can contain cemented zones and hardpan that can be very difficult to excavate with conventional machinery. Excavations in these types of soils are relatively common, and contractors are familiar with methods to handle excavations in hardpan.

Throughout the Tehachapi Mountains, bedrock is generally shallow or at the ground surface, requiring the use of rippers and blasting to excavate. Permanent cuts to bedrock would generally extend to less than 200 feet in depth, but a few areas would exceed 400 feet. The contractor would use rock coring equipment where overcrossings require drilled foundations. Drilling and blasting would also be necessary to create tunnels of lengths between approximately 1,500 and 12,000 feet.

Project construction would include the use of methods in the *Caltrans Construction Site Best Management Practices (BMPs) Manual* (Caltrans 2003b) and the *Construction Site Best Management Practice (BMP) Field Manual and Troubleshooting Guide* (Caltrans 2003a), such as pre-drilling using rock bits for drilled piers/piles or the use of backhoe-mounted hydraulic impact hammers for shallow excavations. Preparation of a construction management plan addressing how the contractor would address geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would also minimize risks associated with difficult excavation.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would be developed in locations that are difficult to excavate due to bedrock and hardpan. This would be especially true in the area of the Tehachapi Mountains, where tunneling would be required. Methods would be implemented to safely bore through difficult excavation areas while ensuring the design structure of tunneling is secure. With implementation of the above-stated IAMFs, the impact from difficult excavations due to bedrock and hardpan during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #5—Potential Exposure to Hazardous Gas During Construction

The B-P Build Alternatives have the potential to affect active oil wells in the Edison area, east of the Bakersfield Station. Active wells would require capping and abandonment or relocation, potentially to nearby locations, using directional drilling techniques, if feasible. The project may also require relocation of appurtenant facilities such as pipelines if they fall within the project footprint.

As previously shown on Figure 3.9-16, the B-P Build Alternatives would be constructed on oil fields. Table 3.9-7 shows the total acreage of construction that would take place on oil fields. All of the B-P Build Alternatives, except B-P Build Alternative 2, would result in construction activities on 370.7 acres of oil fields. B-P Build Alternative 2 would result in construction activities on 345.6 acres, which is the smallest area of all the B-P Build Alternatives. There would be no change in the number of acres of oil fields affected with the CCNM Design Option or the Refined CCNM Design Option. The LMF/MOWF/MOIS facilities under B-P Build Alternative 2 would result in construction activities on 13.3 more acres on the Edison Oil Field and under B-P Build Alternatives 1, 3, and 5 would result in construction activities on 18.4 more acres on the Edison oil field.

Table 3.9-7 Acreage of Bakersfield to Palmdale Project Section Construction on Oil Fields

Oil Field	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/MOIS Facilities
Edison	358.5	333.4	358.5	358.5	No change	No change	+13.3 (Alt. 2) +18.4 (Alt. 1, 3, 5)
Fruitvale	12.2	12.2	12.2	12.2	No change	No change	0
Total	**370.7**	**345.6**	**370.7**	**370.7**	**No change**	**No change**	**+13.3 or +18.4**

Source: *California Department of Conservation, DOGGER, 2012*
CCNM = César E. Chávez National Monument
LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

As previously shown on Figure 3.9-17, there are oil wells along the proposed B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option) and none in the LMF/MOWF/MOIS facilities footprint. Table 3.9-8 shows the total number of oil wells within the construction footprint for each of the B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities footprints.

Table 3.9-8 Number of Oil Wells within the Bakersfield to Palmdale Project Section Construction Footprint

Oil Well	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF /MOIS Facilities
Oil Wells	18	21	19	18	No Change	No Change	0

Source: *California Department of Conservation, DOGGER, 2015*
CCNM = César E. Chávez National Monument
LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

There is also a potential for off-gassing from inactive or abandoned wells within the Edison Oil Field. However, the B-P Build Alternatives are not in a tunnel and does not have any deep cuts in this section. The Phase II fieldwork would include further investigation of the potential for off-gassing. Additionally, portions of the alternatives may overlie radon deposits. Radon is a radioactive, colorless, odorless, tasteless gas that occurs through the decay of uranium and thorium. It is a potentially deadly gas that can accumulate in the bottom levels of buildings constructed over certain types of crystalline geologic materials, such as granite, schist, and gneiss. Radon could therefore potentially represent a hazard to HSR buildings in the portion of the alignment in the Tehachapi Mountains.

Underground construction areas could expose workers to hazardous gases such as radon. Active monitoring systems and alarms would be necessary where subsurface gases are present. Implementation of these systems would minimize the impacts of subsurface gases on workers during construction. GEO-IAMF#3 addresses monitoring to avoid impacts associated with potentially hazardous gases. Methods include compliance with strict federal and state regulatory requirements, and safe practices and regular gas testing during construction.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would be developed in areas where inactive or abandoned wells could generate off-gassing. Additionally, underground construction areas have the potential to release hazardous gases. BMPs, such as active monitoring systems and alarms, would be used to warn construction workers of potential toxic levels of gas. Additionally, with implementation of the above-stated IAMF, the impact from potential exposure to hazardous gas during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #6—Potential Encounters with Abandoned Mines During Construction

Abandoned mines generally occur near and through areas of historic mining in the Tehachapi Mountains and Antelope Valley. The hazards from abandoned mines are dependent on the type of material mined, the depth and extent of the mine workings, and groundwater conditions. During construction, mine collapse is of concern to HSR workers.

Depending on the properties of an individual mine, several steps can be taken to ensure safety during construction. Prior to construction, planned LiDAR surveys would aid in the detection of abandoned mine shafts and mine tailings. GEO-IAMF#4 addresses steps to mitigate hazards associated with abandoned mines. These measures include CERCLA and non-CERCLA cleanup in the event that abandoned mines are found, as well as safety mitigation to remove dangerous structures.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities are in areas where abandoned mines are located. Mine collapse and the structural integrity of nearby mines could occur and be affected with implementation of the project. Surveys would be conducted to determine the locations of mineshafts. With these surveys and implementation of the above-stated IAMF, the impact from potential encounters with abandoned mines during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #7—Potential Exposure to Hazardous Minerals During Construction

Asbestos and mercury are two of the more common hazardous geologic minerals that may be found in California. Naturally occurring mercury is present in the western foothills of Kern County and in the San Emigdio Mountains. The presence of naturally occurring hazardous minerals such as asbestos and mercury would be of concern for workers during construction. Asbestos occurs in ultramafic rocks and is unlikely to be present. Mercury ore mining has previously occurred within the project limits, and construction may encounter mercury ore.

GEO-IAMF#5 would be implemented to address the potential impacts of hazardous minerals during construction. Prior to construction, the contractor would submit a hazards management plan that outlines steps taken to minimize or avoid impacts related to hazardous minerals. If project construction encounters hazardous minerals, several steps can be taken, such as dust control, control of soil erosion and water runoff, and testing and proper disposal of excavated material.

CEQA Conclusion

The potential exists for construction workers to be exposed to hazardous geological minerals during construction of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. With implementation of the above-stated IAMF, the impact from potential exposure to hazardous minerals during construction would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Paleontological Resources

Impact Paleo-1: Geologic Units Sensitive to Unknown Paleontological Resources

Construction activity associated with the development of any of the B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option), the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would disturb geologic units with "high" and "high at depth" (at or below 5 feet) paleontological sensitivity (Figure 3.9-A-2 [Sheets 1 through 13] and Table 3.9-A-1 in Appendix 3.9-A). The B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option) could result in the disturbance of significant paleontological resources at or below the surface in areas of "high" paleontological sensitivity, as well as disturbance of significant paleontological resources at unknown depths below the surface (below 5 feet) in areas of "high at depth" paleontological sensitivity. Figure 3.9-A-2 (Sheets 1 through 13) and Table 3.9-A-1 in Appendix 3.9-A show the segments of the B-P Build Alternatives that cross "high" and "high at depth" sensitivity paleontological units. Alluvial sediments are generally not sensitive at the surface but may become sensitive at unknown depths where they reach an age of early Holocene (5,000 years old or greater) and overlie Pleistocene-aged sediments with high paleontological sensitivity. Pleistocene nonmarine alluvium, fan deposits, and terraces have a record of abundant and diverse vertebrate fauna throughout California and are generally considered to have high paleontological sensitivity wherever they occur. Anaverde Formation, Kern River Formation, and Bena Gravel deposits also occur in the alignment and have high paleontological sensitivity. These geologic units could yield scientifically significant paleontological resources during project-related construction activities.

B-P Build Alternatives 1, 2, and 5 cross 8.9 miles of geologic units with "high" paleontological sensitivity and 48.32 miles of geologic units with "high at depth" paleontological sensitivity (i.e., areas mapped as Holocene alluvium at the surface). B-P Build Alternative 3 crosses 8.35 miles of geologic units with "high" paleontological sensitivity and 47.4 miles of geologic units with "high at depth" paleontological sensitivity (i.e., areas mapped as Holocene alluvium at the surface). Refer to the Bakersfield to Palmdale Project Section Paleontological Resources Technical Report, for details.

B-P Build Alternatives 1, 2, and 5 would result in the same area of disturbance to geologic units with "high" paleontological sensitivity and geologic units with "high at depth" paleontological sensitivity, resulting in the largest area of disturbance to geologic units that could yield scientifically significant paleontological resources. B-P Build Alternative 3 would result in the smallest area of disturbance to geologic units that could yield scientifically significant paleontological resources. However, implementation of GEO-IAMF#15, GEO-IAMF#12, GEO-IAMF#13, GEO-IAMF#14, GEO-IAMF#15, GEO-IAMF#9, GEO-IAMF#2, GEO-IAMF#7, GEO-IAMF#8, and GEO-IAMF#6, described in Appendix 2-E, along with LGA paleontology-related mitigation measures would eliminate any potential direct impact on paleontological resources by requiring paleontological monitoring and procedures should construction activities uncover fossils. GEO-IAMF#9 would engage a qualified paleontological resource specialist to review final design and develop a detailed Paleontological Resources Monitoring and Mitigation Plan to ensure paleontological resources are not disturbed during project construction. GEO-IAMF#2 requires the paleontological resource specialist to perform final design review and triggers evaluations by evaluating the 90 percent project design submittal to identify portions of the construction that would involve work in paleontologically sensitive geologic units. This IAMF would identify where sensitive resource areas may be and would allow proper mitigation to be applied to reduce impacts on paleontological resources. GEO-IAMF#7 would require the preparation and implementation of a Paleontological Resources Monitoring and Mitigation Plan to ensure mitigation measures are applied to help reduce impacts on paleontological resources. GEO-IAMF#8 requires the construction contractor to provide paleontological resources worker environmental awareness program (WEAP) training delivered by the supervising paleontologist to educate construction workers about the potential discovery and protection of paleontological resources. GEO-IAMF#6 puts in place procedures to halt construction, evaluate findings, and treat paleontological resources if they are found during construction.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities have the potential to be constructed on geological units with “high” and “high at depth” sensitivity for paleontological resources. If resources are discovered during construction activities, implementation of the above-stated IAMFs and LGA paleontology mitigation measures would ensure that impacts on paleontological resources would be less than significant under CEQA. Please refer to Section 3.1 Introduction, Section 3.1.3.7, for further discussion on how mitigation measures are implemented among the B-P Build Alternatives and the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street.

Operations Impacts

Geology, Soils, and Seismicity

Compared to the construction-period impacts, geologic risks during operation of the project are only different in that the exposure period extends for the life of the project. This longer exposure period increases the potential risks from localized deposits of soft or loose soils, areas with potential for ground settlement, expansive soils with high shrink-swell characteristics and high corrosivity potential, and slope failure, as well as seismic risks. As noted for the construction-period considerations, conducting investigations and implementing design methods that conform to construction design standards and building code requirements would aid in management of these risks.

Impact GSS #8—Effects of Unstable Soils During Operations

The potential for impacts from unstable soils during project operation is the same as that described for project construction, except that the exposure period increases. With the longer exposure period, the potential for creep- or groundwater-related soil failures increases. The unstable soils consist of loose or soft deposits of sands, silts, and clays that can occur on a localized basis and are likely to be more prevalent near river and stream crossings. The impacts from soft or loose soils would affect some design types more than others.

For instance, at-grade segments of the alignment do not pose a great risk on the unstable soil. Typically, elevated structures supported on deep foundations are specifically designed to handle soft, near-surface soils. Where soft-soil conditions are combined with the potential for small slumps and slope failures, however, the severity of the risk increases. In these locations, the potential impact of loss in bearing or additional soil loads associated with the slump or slope failure are also important factors to consider.

The HSR project design would incorporate design methods that would consider the short- and long-term impacts of unstable soils on the B-P Build Alternatives (including the CCNM Design Option and Refined CCNM Design Option), the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. Where appropriate, project design would include engineered ground improvements, such as regrading or groundwater controls, to avoid long-term impacts from unstable soils. Implementation of these methods during final design would meet the standards of design and building code requirements to provide either sufficient bearing capacity and slope stability, or measures that protect the facility from loads associated with unstable soils. Preparation of a construction management plan addressing how the contractor would address specific geologic constraints (GEO-IAMF#1) and implementation of the guidelines and standards outlined in GEO-IAMF#10 would minimize risks associated with unstable soils during operation. GEO-IAMF#1 would require preparation of a construction management plan addressing groundwater withdrawal, unstable soils, subsidence, water and wind erosion, soils with shrink-swell potential, and soils with corrosive potential, as well as the type of action to take if any of these geological/geotechnical constraints are identified prior to or during project construction. GEO-IAMF#10 requires the incorporation of slope monitoring by a Registered Engineering Geologist to ensure that slope failure is recognized and corrective action is issued to reduce potential project impacts.

CEQA Conclusion

Potential operations impacts due to placement of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities on unstable soil would be similar to construction impacts. Design methods would be incorporated to minimize development on unstable soils. With implementation of the above-stated IAMFs, the impact from unstable soils during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #9—Effects of Soil Settlement During Operations

Soil settlement could occur during project operation due to regional subsidence and on a local scale at locations where soft deposits of silty or clay soils are subjected to new earth loads, as might occur with approach fills for elevated guideways, or for track subgrade and ballast materials placed to meet track grade requirements. A number of locations along the project footprint would require new earth fills. Settlement-prone (loose or soft) soils may potentially underlie some of these areas.

The potential consequence of excessive settlement represents a high risk to HSR travel if unaddressed. However, regional subsidence and localized settlement are typically slow processes that, with periodic maintenance, are remediable. Several geologic resources IAMFs listed in Section 3.9.4.2 include methods to address the impacts of soil settlement during operations. Preparation of a construction management plan addressing how the contractor would address specific geologic constraints (GEO-IAMF#1) would occur prior to project construction. Pre-construction and construction investigations would identify specific settlement-prone locations. The project would incorporate engineering design features that address soft deposits of silty clay soils, such as pre-loading to accelerate settlement or adding wick drains if applicable.

Additionally, the HSR project design would incorporate design methods that consider the short- and long-term impacts of unstable soils on the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option), the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. Where appropriate, the project would implement engineered ground improvements, including regrading or groundwater controls, to avoid long-term impacts from unstable soils. Implementation of these methods during final design would meet the standards of design and building code requirements, outlined in GEO-IAMF#10, to provide either sufficient bearing capacity and slope stability, or measures that protect the facility from loads associated with unstable soils. Implementation of these design measures would reduce the potential impacts of soft or loose soils because loose and unstable soils would be improved or foundations would be designed to avoid impacts on structures from these conditions. The project would import additional fill material from other sources as necessary.

Methods described in GEO-IAMF#1c would address regional subsidence specifically. These methods include topographic surveys used for preparation of final design. The surveys would also serve as benchmarks from which ongoing subsidence can be monitored. GEO-IAMF#9 addresses a subsidence monitoring program that includes track inspection systems that provide early warning of reduced track integrity. Where problems arise, dressing and/or reballasting where required could help to maintain a safe track profile.

Preparation of a construction management plan (GEO-IAMF#1) and conformance with the standards and guidelines outlined in GEO-IAMF#10, as well as the subsidence monitoring program (GEO-IAMF#9), would provide adequate solutions to potential soil settlement during project operation.

CEQA Conclusion

With implementation of the above-stated IAMFs, the impact from soil settlement during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #10—Effects of Moderate to High Shrink-Swell Potential During Operations

As previously shown on Figure 3.9-5, the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option), the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities generally traverse (and are in) areas with soils that have low expansive potential. The potential for highly expansive soils along the B-P Build Alternative alignment occurs where the alignment intersects Caliente Bodfish Road on the northern side of the Tehachapi Mountains. Moderately expansive soil potential exists in several locations along the B-P Build Alternative alignment: at the start of the project section south of the alignment, in the vicinity of Caliente Creek, and in the Tehachapi Valley.

Table 3.9-9 shows the total acreage of soils with moderate or high expansive potential that the B-P Build Alternatives would cross. All of the B-P Build Alternatives would be on 6.9 acres of soils with high expansive potential. Implementation of the CCNM Design Option would increase the 6.9 acres of soils with high expansive potential by 14.7 acres for each B-P Build Alternative. Implementation of the Refined CCNM Design Option would increase the acres of soils with moderate expansive potential by 99.1 acres for each B-P Build Alternative. B-P Build Alternative 3 would be on the largest area (313.5 acres) of soils with moderate expansive potential, and B-P Build Alternative 2 would be on the smallest area (292.1 acres). B-P Build Alternatives 1 and 5 would both be on 294 acres. The CCNM Design Option would reduce the acres of soils with moderate expansive potential by 11.1 acres for each B-P Build Alternatives. The LMF/MOWF/MOIS facilities would not be on soils with moderate and high expansive potential (similar to construction conditions).

Table 3.9-9 Soils with Moderate and High Expansive Potential Crossed by the B-P Build Alternatives (acres)

Soil Expansive Potential	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option
Moderate Expansive Potential	294.0	292.1	313.5	294.0	-11.1	+99.1
High Expansive Potential	6.9	6.9	6.9	6.9	+14.7	No change
Total	**300.9**	**299.0**	**320.4**	**300.9**	**+3.6**	**+99.1**

Source: *United States Department of Agriculture, 2013*
B-P = Bakersfield to Palmdale Project Section
CCNM = César E. Chávez National Monument
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

The potential for shrink-swell soils, if unchecked, represents a risk to the operation of the track system and the track right-of-way for long-term operations. This type of impact is more critical to locations with at-grade segments than to elevated structures on deep foundations. The earth loads associated with at-grade segments of the alternatives may not be sufficient to overcome shrink-swell potential, and this swell would likely be variable along the alignment, leading to differential movement of the track system. Special engineering or construction considerations would be necessary where the B-P Build Alternative alignments traverse expansive soils. GEO-IAMF#10 includes geotechnical engineering guidelines and standards that would minimize the hazards related to expansive soils. These standards include a subsurface drilling and laboratory testing program. Additionally, specific methods, such as those discussed in GEO-IAMF#1e, would address constraints identified in the project construction management plan. Methods include mixing soil additives with existing soil to reduce shrink-swell potential. Incorporating the guidelines and standards from GEO-IAMF#10 and the specific methods in GEO-IAMF#1e would reduce risks from shrink-swell soils.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would traverse and operate in areas with expansive soils. Special engineering considerations would be applied as part of the design for the project traversing these locations. With implementation of the above-stated IAMFs, the impact from soils with moderate to high shrink-swell potential during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #11—Effects of Moderately to Highly Corrosive Soils During Operations

As previously shown on Figure 3.9-6 and Figure 3.9-7, the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) generally traverse areas with soils that have low corrosivity to concrete but moderate to high corrosivity to steel. Table 3.9-4 outlines soils along all of the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and at the LMF/MOWF/MOIS facilities. These soils generally have moderate to high corrosivity to uncoated steel as well as concrete in some locations.

Table 3.9-10 shows the total acreage of soils with moderate and high corrosive potential to concrete and steel that the B-P Build Alternatives would cross. All of the B-P Build Alternatives except B-P Build Alternative 3 would be on 359.7 acres of soils with moderate corrosive potential to concrete. B-P Build Alternative 3 would be on 415.4 acres, which is the largest area among the B-P Build Alternatives. B-P Build Alternative 3 would also be on the largest area of soils with high corrosive potential to concrete (235.5 acres), whereas B-P Build Alternative 2 would be on the smallest area (226.4 acres). B-P Build Alternatives 1 and 5 would both be on 235.5 acres of soils with high corrosive potential to concrete. B-P Build Alternative 1 would be on the largest area of soils with moderate corrosive potential to steel (2,708.3 acres), and B-P Build Alternative 3 would be on the smallest area (2,689.8 acres). B-P Build Alternatives 2 and 5 would be on 2,700.1 acres and 2,695.1 acres, respectively. B-P Build Alternative 3 would be on the largest area of soils with high corrosive potential to steel (4,426.4 acres), and B-P Build Alternative 2 would be on the smallest area (4,335.9 acres). B-P Build Alternatives 1 and 5 would be on 4,384.4 acres and 4,338.7 acres, respectively. The CCNM Design Option would not change the number of acres of soils corrosive to concrete for each B-P Build Alternative. It would, however, increase the number of acres of soils corrosive to steel for each of the B-P Build Alternatives by 23.4 acres. The Refined CCNM Design Option would change the number of acres of soils corrosive to concrete for each B-P Build Alternative by 245.4 acres. Additionally, it would increase the number of acres of soils corrosive to steel for each of the B-P Build Alternatives by 677.5 acres.

The potential for corrosion to uncoated steel and concrete represents a significant risk to the long-term operation of the track system and the track right-of-way. Consequences of corrosion could include eventual loss in the structural capacity of buried steel or concrete components. Where buried concrete or steel portions of the project structures would be located in areas with potentially corrosive soils, the soils would be analyzed by standard geotechnical engineering testing and soil resistivity surveys to identify the extent of the problem. The construction management plan, prepared prior to project construction, will incorporate the results of these tests and surveys (GEO-IAMF#1). Minimization measures usually include designing the concrete mix for the potential hazard, increasing the amount of concrete cover for buried reinforced concrete structures, and protecting buried steel structures with special coatings or cathodic protection. The project design also reduces the risk from corrosive soils through soil improvement, as discussed in GEO-IAMF#1e. Surface soils that exhibit corrosive characteristics would be removed and replaced in areas where uncoated steel would be buried. Active and passive corrosion protection systems would also protect embedded and exposed steel structures from corrosion. As necessary, final designs would include epoxy-coated steel or double corrosion-protection ground anchors to avoid long-term corrosion issues.

Table 3.9-10 Soils with Moderate and High Corrosive Potential Crossed by the B-P Build Alternatives (acres)

Soil Corrosivity Potential	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option
Corrosive Potential to Concrete						
Moderate Corrosive Potential	359.7	359.7	415.4	359.7	No Change	+245.4
High Corrosive Potential	235.5	226.4	235.5	235.5	No Change	No change
Total	**595.2**	**586.1**	**650.9**	**595.2**	**No Change**	**+245.4**
Corrosive Potential to Steel						
Moderate Corrosive Potential	2,708.3	2,700.1	2,689.8	2,695.1	+16.7	+474.8
High Corrosive Potential	4,384.4	4,335.9	4,426.4	4,338.7	+6.7	+202.6
Total	**7,092.7**	**7,036**	**7,116.2**	**7,033.8**	**+23.4**	**+677.5**

Source: *United States Department of Agriculture, 2013*
B-P = Bakersfield to Palmdale Project Section
CCNM = César E. Chávez National Monument
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would be located and operated on soils with moderate and high corrosive potential to concrete and steel. Design techniques would be implemented to reduce potential impacts on the structural integrity of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities in locations where corrosive soil exists. With implementation of the above-stated IAMF, the impact from moderately to highly corrosive soils during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #12—Effects of Slope Failure During Operations

Slopes along some rivers and streams could fail, either from additional earth loads at the top of the slope, undercutting by stream erosion at the toe of the slope, or additional seismic forces during a seismic event. The consequences of slope failure would be either loss of bearing support to the track facilities or increased load on structures in the path of the slope failure. The former represents a higher risk because of the flat topography along the alternatives. Loss in bearing support would affect at-grade sections more than cut sections and elevated structures supported on deep foundations. These failures could endanger people and on- and off-site structures in the event of damage to the HSR track.

The HSR project design addresses slope stability by incorporating standard IBC and other engineering standards and criteria, including those outlined in GEO-IAMF#10. A Registered Engineering Geologist would conduct detailed slope stability evaluations and incorporate them into the pre-construction management plan for Authority approval (GEO-IAMF#1). Implementation of 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), as appropriate would 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. In the case of elevated structures, the location of the foundation would be sited during final design to avoid the area of slope failure. Additionally, per GEO-IAMF#2, the operation and maintenance procedures would include slope monitoring by a Registered Engineering Geologist. Implementation of these procedures would occur at sites identified in the construction management plan where the potential for long-term instability exists.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would be located in portions of streams and rivers where slope failure could occur. Design techniques would be implemented as part of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities that would reduce the potential for slope failure. With implementation of the above-stated IAMFs, the impact from slope failure during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Impact GSS #13—Effects of Seismicity during Operations

Although the project would not cause or exacerbate seismic activity or associated hazards, earthquakes could produce hazards to the HSR system. These include moderate to high seismic ground motions (e.g., peak ground acceleration), as in the primary seismic hazards discussion in Section 3.9.5.2, and the risks from secondary seismic hazards associated with large seismically induced ground motions.

Seismically Induced Ground Shaking

The entire length of the alignment in the B-P Section is within Seismic Zone 4 (1 in 10 chance that an earthquake with an active peak acceleration level of 0.40g will occur in the next 50 years). Faults in the project vicinity have produced historic earthquakes with magnitudes of up to M7.9. The level of ground shaking could vary along the alignment, depending on the amount of ground motion amplification or deamplification within specific soil layers. However, the likely level of seismically induced ground motion is enough to cause damage regardless of the specific location. The level of ground shaking represents a critical hazard to all design types.

A key consideration is the response of the operating HSR system to a seismic event that shakes the track. Movement of the track bed would be transferred to the train. The train cars, the spring system for the train cars, and the track design would be appropriately configured to resist the resulting inertial response of the train while it is traveling at a high speed. Available information for other HSR systems in seismically active areas, such as Japan, suggests that the California HSR System would be able to satisfy life-safety requirements for the design earthquake.

The B-P Build design would address seismically induced ground shaking through the evaluation and design methods described in GEO-IAMF#7. The contractor would conduct detailed seismic response evaluations, and prior to construction, document the results in a TM outlining how all HSR components were evaluated and designed for large seismic ground shaking. Additional seismic studies prior to final design would establish up-to-date estimation of the levels of ground motion. The most current Caltrans seismic design criteria would be used to reduce potential movements, shear forces, and displacements that result from inertial response of the structure. The HSR design would address the train's performance by specifically evaluating the response of the track system, confirming that the soil provides sufficient support to the track, and specifying minimum seismic loading requirements for elevated structures. The project would use elevated structures supported on deep foundations that are designed for movement and shear forces associated with ground shaking of a certain magnitude, as outlined in TM 2.10.4 (Authority 2009b). Additional methods outlined in GEO-IAMF#7 include pendulum base isolators to reduce the levels of inertial forces and new composite materials to enhance seismic performance.

In addition, GEO-IAMF#8 includes the installation of a network of instruments to provide ground motion data for use with the HSR instrumentation and controls system to temporarily shut down the HSR operations in the event of an earthquake. Installation of train derailment containment devices would occur in sections across hazardous fault zones as a track safety precaution. After a seismic event, the contractor would inspect the system for damage and return it to service when deemed appropriate. The guidelines and standards outlined in GEO-IAMF#10 and in *TM 2.9.10: Geotechnical Analysis and Design Guidelines* address further design considerations for seismic ground shaking.

Surface Fault Rupture

As shown previously on Figure 3.9-12, the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) cross over multiple faults. Table 3.9-11 shows the number of instances where the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) cross a fault. The number of fault crossings is the same for each of the B-P Build Alternatives. The LMF/MOWF/MOIS facilities cross the Edison Fault Zone (AP-Partial) one time when compared to the B-P Build Alternatives 1, 2, 3 and 5.

Table 3.9-11 Number of Fault Crossings Within the Bakersfield to Palmdale Project Section

Fault Zone	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Antelope Valley Fault Zone	1	1	1	1	No Change	No Change	0
Edison Fault Zone (AP – Partial)	3	3	3	3	No Change	No Change	1
Garlock Fault Zone (AP)	1	1	1	1	No Change	No Change	0
Rosamond Fault Zone	1	1	1	1	No Change	No Change	0
Tehachapi Creek Fault Zone	9	9	9	9	No Change	No Change	0
White Wolf Fault Zone (AP)	3	3	3	3	No Change	No Change	0
Total	**18**	**18**	**18**	**18**	No Change	No Change	1

Source: *United States Department of Agriculture, 2013, and California High-Speed Rail Authority, 2019*
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.
AP = Alquist-Priolo
CCNM = César E. Chávez National Monument
LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility

Table 3.9-12 shows the distance the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities would travel or placed within fault zones. B-P Build Alternative 3 would travel through 4.98 miles of fault zones, which is the most among the B-P Build Alternatives, while B-P Build Alternative 5 would travels through 4.91 miles, which is the least. B-P Build Alternative 1 and Alternative 2 travel 4.93 and 4.95 miles, respectively. The CCNM Design Option does not change the number of times the B-P Build Alternatives would traverse fault zones, but it does reduce the area that each alternative would cross the Tehachapi Creek fault by 1.51 acres. The Refined CCNM Design Option would increase the area that each alternative would cross the Tehachapi Creek Fault Zone by 0.6 acre. The LMF/MOWF/MOIS facilities would increase the area that B-P Build Alternatives 1, 3, and 5 cross the Edison Fault Zone (AP-Partial) by 0.4 mile and B-P Build Alternative 2 by 0.1 mile.

Table 3.9-12 Bakersfield to Palmdale Project Section Mileage within Fault Zones

Fault Zone	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Antelope Valley Fault Zone	0.08	0.08	0.08	0.06	No Change	No Change	0
Edison Fault Zone (AP – Partial)	0.52	0.54	0.52	0.52	No Change	No Change	+0.4 mi - Alt. 1, 3, 5 +0.1 mi – Alt. 2
Garlock Fault Zone (AP)	0.25	0.25	0.30	0.25	No Change	No Change	0
Rosamond Fault Zone	0.15	0.15	0.15	0.15	No Change	No Change	0
Tehachapi Creek Fault Zone	3.38	3.38	3.38	3.38	-1.51	+0.6	0
White Wolf Fault Zone (AP)	0.55	0.55	0.55	0.55	No Change	No Change	0
Total	**4.93**	**4.95**	**4.98**	**4.91**	**-1.51**	**+0.6**	**+0.1 or +0.4**

Source: *United States Geological Survey, 2012 and California High-Speed Rail Authority, 2019*
AP = Alquist-Priolo
CCNM = César E. Chávez National Monument
LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

Surface fault rupture is a possible problem at the locations where the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) cross known hazardous faults: the White Wolf and Garlock faults. At these discrete locations in the alternatives' alignments where the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) intersect mapped fault traces, specialized engineering design considerations would be necessary to minimize the impacts of surface fault rupture (Authority 2009a, 2010). No tunneling would take place at these fault crossings or in Alquist-Priolo Earthquake Fault Zones. TM 2.9.3, TM 2.9.6, and the standards and guidelines outlined in GEO-IAMF#10 provide further discussion of engineering design considerations pertaining to surface fault rupture.

Evaluation of the potentially hazardous faults that the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) cross or come close to—the Edison, the Tehachapi Creek, and the Willow Springs faults—would take place to confirm that these faults have not ruptured the ground surface during Holocene time. While ground rupture along active faults can rarely be fully mitigated, implementation of early warning systems (GEO-IAMF#6) triggered by ground motion can aid in monitoring movement at fault crossings. Damage from fault creep detected through monitoring can be mitigated with routine maintenance such as repaving or realignment. In addition, the project would include installation of linear monitoring systems to temporarily control traffic and trains and avoid accidents in the event of ground rupture.

If an earthquake occurs on any of the fault crossings, engineering minimization measures would include continuous monitoring and immediate shutdown of this section of the HSR to allow track surveying and confirmation of acceptable conditions before service resumes. GEO-IAMF#8 details the suspension of operations during an earthquake. If damage from fault rupture were to occur along these alignments, it would be repaired with emergency maintenance, which could include repaving or track realignment.

Secondary Seismic Hazards

As previously shown on Figure 3.9-9, the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities would traverse areas with high potential for liquefaction. Section 3.9.5.2 discusses potential seismic liquefaction and lateral spreading. As noted, available information suggests that liquefaction in the RSA may occur at stream crossings in the Tehachapi Valley, in Lancaster, and near the Palmdale Station. At locations where groundwater and soil foundation conditions are favorable with respect to development of strength loss from liquefaction, deep foundations typically provide structural support through liquefied layers.

Table 3.9-13 shows the total acreage with high potential for liquefaction that the B-P Build Alternatives would cross. All of the B-P Build Alternatives would be on 22.5 acres with both seismic hazard and liquefaction risk, with the exception of the CCNM Design Option, which would reduce the number of acres by 0.1 acre for all B-P Build Alternatives. The Refined CCNM Design Option would increase the number of acres by 8.5 for all B-P Build Alternatives. Overall, B-P Build Alternative 3 would be on the largest area with high potential for liquefaction (231.5 acres) and B-P Build Alternative 5 would be on the smallest area (229.5 acres). Alternatives 1 and 2 would both be on 229.6 acres. Overall, the Refined CCNM Design Option would increase the number of acres of liquefaction risk by 72.4 for all B-P Build Alternatives. The LMF/MOWF/MOIS facilities, overall, would increase the number of acres of liquefaction risk by 12.4 for all B-P Build Alternatives.

Table 3.9-13 Liquefaction Risk Areas Crossed by the B-P Build Alternatives (acres)

High Liquefaction Potential	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Seismic Hazard/ Liquefaction Risk	22.5	22.5	22.5	22.5	-0.1	+8.5	0
Liquefaction Risk	409.0	409.0	410.0	409.0	-5.2	+63.9	+12.4
Total Liquefaction Risk	**229.6**	**229.6**	**231.5**	**229.5**	**-5.3**	**+72.4**	**+12.4**

Source: *California Department of Conservation, 2005 and Kern County, 2015*

Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

B-P = Bakersfield to Palmdale Project Section

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Lateral spreading is anticipated in localized areas throughout the alignment, such as at selected stream crossings, and areas south of the Palmdale Station. At these select locations, the impacts of lateral spreading would be addressed by conventional engineering design consisting of ground improvement or a structural solution. The standards and guidelines in GEO-IAMF#10 include these conventional engineering design methods. In addition, prior to construction of the project alignment, the construction management plan would outline how the contractor would address specific geologic constraints, such as liquefaction and lateral spreading.

Detailed slope-stability evaluations and implementation of engineering measures, such as ground improvement, use of retaining walls, or regrading of slopes, as appropriate, will reduce the potential for seismically induced landslides. Localized instabilities that may occur would be handled as a maintenance issue. Additionally, GEO-IAMF#2 describes incorporating slope monitoring by a Registered Engineering Geologist into the operation and maintenance procedures.

Potential dam failures at Lake Isabella Dam and Blackburn Dam could result in inundation of the HSR system; see Figure 3.9-15 for the locations of these dams. Table 3.9-14 shows the total acreage that the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities would cross that could be inundated if the dams were to fail. The B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and the LMF/MOWF/MOIS facilities would be located within the Blackburn, Antelope, and Isabella dam inundation zones. Overall, B-P Build Alternative 3 would be on 353 acres of dam inundation zone and B-P Build Alternatives 1, 2, and 5 would be on 350.3 acres. Implementation of CCNM Design Option would not change the amount of acres the B-P Build Alternatives would have in dam inundation zones; however, implementation of the Refined CCNM Design Option would reduce the amount of B-P Build Alternatives in dam inundation zone areas by 7.35 acres. Overall, the LMF/MOWF/MOIS facilities would increase the amount of land (in a dam inundation zone) that the B-P Alternatives would be in by 12.4 acres.

Table 3.9-14 Dam Inundation Zones Crossed by the B-P Build Alternatives (acres)

Dam Inundation Zone	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/MOIS Facilities
Blackburn	145.2	145.2	147.9	145.2	No change	No change	+12.4
Antelope	17.44	17.44	17.44	17.44	No change	-7.35	0
Isabella	205.1	205.1	205.1	205.1	No change	No change	0
Total	**350.3**	**350.3**	**353**	**350.3**	**No change**	**-7.35**	**+12.4**

Source: *California Office of Emergency Services, 2015*
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.
B-P = Bakersfield to Palmdale Project Section
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The inundation area is a conservative scenario and indicates that the failure of Lake Isabella Dam could result in inundation of the northwestern most portion of the project section, near the Bakersfield Station, by as much as 20 feet of water. It would take an estimated 6 to 8 hours for escaped water to reach a flooding depth of 1 foot at the proposed Bakersfield Station (Kern County Planning Department 2008). This flooding depth takes into consideration topography and narrow or choke points along existing drainages. Therefore, in the unlikely event that Lake Isabella Dam did fail, this should allow ample time to evacuate the F Street Station. It should be noted that Lake Isabella Dam is being operated (at the time of preparation of this document) at a lowered pool elevation (no more than 66 percent of its capacity) to reduce the risk of flooding if the dam were to breach. Studies are underway on a dam remediation program to reduce the risk of dam failure. These methods would ultimately improve and presumably eliminate the risk of impacts on the proposed HSR system.

The Tehachapi Valley—Blackburn Dam is 1.6 miles southwest of the project alignment. The project alignments cross the inundation area for Blackburn Dam (California Office of Emergency Services 2015). In the event of a catastrophic dam failure, flows from Blackburn Dam would move east toward Proctor Lake. This dam is designed to withstand the maximum credible earthquake.

A seismically induced dam failure at Lake Isabella Dam and Blackburn Dam is unlikely because the seismic event would need to be large enough to cause catastrophic damage to the dam structure. Due to the B-P Build Alternatives (including the CCNM Design Option and the Refined CCNM Design Option) and LMF/MOWF//MOIS facilities being near the limit of the Lake Isabella Dam inundation area, it is also anticipated that there would be sufficient time for evacuation in the event of catastrophic dam failure. Additionally, flows from Blackburn Dam would move east toward Proctor Lake.

CEQA Conclusion

The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities would not cause or exacerbate seismic activity or related hazards, but they would be in an area where seismic events could occur. The B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities could be exposed to seismically induced ground shaking, surface fault rupture, and secondary seismic hazards. With implementation of the above-stated IAMFs, TMs, and design standards, the impact from seismicity during operations would be less than significant under CEQA. Therefore, CEQA does not require any mitigation.

Paleontological Resources

Because impacts on paleontological resources occur from excavations and similar deep ground disturbance, and because these activities would take place during the construction phase only, no impacts on paleontological resources would occur during the operational phase of the project. No mitigation is necessary.

3.9.7 Mitigation Measures

No significant geology, soils, and seismicity impacts would result from implementation of the F-B LGA; therefore, the *Fresno to Bakersfield Section Final Supplemental EIR* (Authority 2018) and the *Final Supplemental EIS* (Authority 2019) did not identify mitigation measures for geology, soils, and seismicity.

However, the *Fresno to Bakersfield Section Final Supplemental EIR* (Authority 2018) and the *Final Supplemental EIS* (Authority 2019) identified the following paleontological resource-related mitigation measures applicable to the portion of the F-B LGA from 34th Street and L Street to Oswell Street. See Section 3.1.3.7 for further information about how LGA mitigation measures are addressed. No additional mitigation measures are necessary for the B-P Build Alternatives and the LMF/MOWF/MOIS facilities:

- **F-B LGA CUL-MM #16:** A paleontological resources specialist (PRS) will be designated for the project who will be responsible for determining where and when paleontological resources monitoring should be conducted. Paleontological resource monitors will be selected by the PRS based on their qualifications, and the scope and nature of their monitoring will be determined and directed based on the Paleontological Resource Monitoring and Mitigation Plan (PRMMP). The PRS will be responsible for developing Worker Environmental Awareness Program training.
- All management and supervisory personnel and construction workers involved with ground-disturbing activities will be required to take this training before beginning work on the project and will be provided with the necessary resources for responding in case paleontological resources are found during construction. The PRS will document any discoveries, as needed, evaluate the potential resource, and assess the significance of the find under the criteria set forth in CEQA Guidelines Section 15064.5.
- **F-B LGA CUL-MM #17:** Paleontological monitoring and mitigation measures are restricted to those construction-related activities that will result in the disturbance of paleontologically sensitive sediments. The PRMMP will include a description of when and where construction monitoring will be required; emergency discovery procedures; sampling and data recovery procedures; procedures for the preparation, identification, analysis, and curation of fossil specimens and data recovered; and procedures for reporting the results of the monitoring and mitigation program. The monitoring program will be designed to accommodate site-specific construction of the selected option. The PRMMP will be consistent with Society of Vertebrate Paleontology (SVP 2010) guidelines for the mitigation of construction impacts on paleontological resources. The PRMMP will also be consistent with the SVP (1996) conditions for receivership of paleontological collections and any specific requirements of the designated repository for any fossils collected.

- **F-B LGA CUL-MM #18:** If fossil or fossil-bearing deposits are discovered during construction, regardless of the individual making a paleontological discovery, construction activity in the immediate vicinity of the discovery will cease. This requirement will be spelled out in both the PRMMP and the WEAP. Construction activity may continue elsewhere provided that it continues to be monitored as appropriate. If the discovery is made by someone other than a Paleontological Resource Monitor or the PRS, a Paleontological Resource Monitor or the PRS would immediately be notified.

3.9.8 NEPA Impact Summary

This section summarizes and compares the impacts of the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, the LMF/MOWF/MOIS facilities, and the No Project Alternative. The NEPA process takes into account the potential impacts on GSSPR in conjunction with potential impacts on all resources to determine the effects of each B-P Build Alternative and the LMF/MOWF/MOIS facilities. The No Project Alternative provides a benchmark for resource impacts.

Under the No Project Alternative, the California HSR System would not be built and the impacts associated with GSSPR under current conditions would continue, including impacts from continued operation of existing highways, airports, and railways. Other projects planned for construction, including transportation improvement projects, would need to comply with federal and state regulatory requirements and implement design requirements during construction and operation to minimize impacts associated with GSSPR. Potential impacts associated with the No Project Alternative include unstable or corrosive soils, as well as geologic and seismic conditions of the San Joaquin Valley, Sierra Nevada, and Mojave Desert.

3.9.8.1 Geology, Soils, and Seismicity

Table 3.9-15 provides a comparison of the impacts of the B-P Build Alternatives (including the F-B LGA from the intersection of 34th Street and L Street to Oswell Street) associated with geology, soils, and seismicity. Data from this table and the information summarized below are described in detail in Section 3.9.6. In additional to implementing construction BMPs and standard engineering design measures, the HSR Build Alternatives incorporate IAMFs that would avoid or minimize impacts associated with geology, soils, and seismicity during construction and operation. These IAMFs would include features for addressing geological constraints and hazards related to unstable soils, soil settlement, soil erosion, difficult excavations, hazardous gas exposure, encounters with abandoned mines, exposure to hazardous minerals, soils with shrink-swell potential, corrosive soils, slope failure, and seismicity.

Table 3.9-15 Comparison of B-P Build Alternative Impacts for Geology, Soils, and Seismicity

Impact	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Construction							
Impact GSS #1: Encountering Unstable Soils During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from encountering unstable soils during construction.						
Impact GSS #2: Soil Settlement at Structures or Along Trackway During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from settlement at structures or along the trackway during construction.						
Impact GSS #3: Soil Erosion During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from soil erosion during construction.						
Soils with Moderate to High Erosion Potential (acres)	4,568.7	4,502.6	4,672.2	4,568.7	+3.6	+701.8	+25.7 (B-P Build Alternative 2) +30.8 (B-P Build Alternatives 1, 3, and 5)
Impact GSS #4: Difficult Excavations Due to Bedrock and Hardpan During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts associated with difficult excavations due to bedrock and hardpan during construction.						
Impact GSS #5: Potential Exposure to Hazardous Gas During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from potential exposure to hazardous gas during construction.						
Oil Fields (acres)	370.7	345.6	370.7	370.7	No change	No change	+13.3 (B-P Build Alternative 2) +18.4 (B-P Build Alternatives 1, 3, 5)
Oil Wells	18	21	19	18	No change	No change	0
Impact GSS #6: Potential Encounters with Abandoned Mines During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from potential encounters with abandoned mines during construction.						

Impact	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Impact GSS #7: Potential Exposure to Hazardous Minerals During Construction	All B-P Build Alternatives and LMF/MOWF/MOIS facilities avoid or minimize impacts from potential exposure to hazardous minerals during construction.						
Operations							
Impact GSS #8: Effects of Unstable Soils during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from unstable soils during operation.						
Impact GSS #9—Effects of Soil Settlement during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from soil settlement during operation.						
Impact GSS #10: Effects of Moderate to High Shrink-Swell Potential during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from soils with moderate to high shrink-swell potential during operation.						
Soils with Moderate to High Expansive Potential (acres)	300.9	299.0	320.4	300.9	+3.6	+99.1	No Change
Impact GSS #11: Effects of Moderately to Highly Corrosive Soils during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from moderately to highly corrosive soils during operation.						
Soils with Moderate to High Corrosive Potential to Concrete (acres)	595.2	586.1	650.9	595.2	No change	+245.4	No Change
Soils with Moderate to High Corrosive Potential to Steel (acres)	7,092.7	7,036	7,116.2	7,033.8	+23.4	+677.5	No Change
Impact GSS #12: Effects of Slope Failure during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from slope failure during operation.						
Impact GSS #13—Effects of Seismicity during Operations	All B-P Build Alternatives and LMF/MOWF/MOIS facilities would avoid or minimize impacts from seismicity during operation.						

Impact	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Mileage within Fault Zones	4.93	4.95	4.98	4.91	- 1.51	+0.6	+0.4 (B-P Build Alternatives 1, 3, and 5) +0.1 (B-P Build Alternative 2)
Liquefaction Risks (acres)	229.6	229.6	231.5	229.5	- 5.3	+72.4	+12.4
Dam Inundation Zones (acres)	350.3	350.3	353.0	350.3	No Change	-7.35	+12.4

Source: California High-Speed Rail Authority, 2019

Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.

B-P = Bakersfield to Palmdale Project Section

CCNM = César E. Chávez National Monument

LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility

Construction impacts related to geology, soils, and seismicity would be the same for all of the B-P Build Alternatives (including the CCNM Design Option and the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street).

Construction of the HSR project on soft or loose soils could result in on- or off-site slumps, small landslides at stream crossings, or instability of cut-and-fill slopes necessary for the HSR tracks, which could endanger people or on-site or off-site properties if not addressed. Although this risk would be greater if a large seismic event were to occur, the likelihood of a large earthquake during construction is considered low because of the comparatively short duration of construction relative to the frequency of large earthquakes. Project design would include GEO-IAMF#1, which requires preparation of a construction management plan to address geological constraints, including those related to unstable soils. The project would also include appropriate design standards (such as Section 1805.3 of the IBC) and standard safety practices.

Although soils along the alignments are generally competent (medium-dense, stiff, or better), localized deposits of soft or loose soils could occur at various locations, particularly at water crossings, where soft or loose soils appear to be more prevalent. In some locations, settlement associated with project construction could also affect nearby existing structures or buried utilities located close to the area of construction. Project design would include GEO-IAMF#1 and GEO-IAMF#10, which require preparation of a construction management plan that addresses specific geologic constraints, including soil settlement, and issuance of a TM documenting how engineering guidelines and standards have been incorporated, respectively.

Accelerated soil erosion, including loss of topsoil, could occur as a result of project construction. B-P Build Alternative 3 would affect the largest area of soils with moderate to high erosion potential (4,672.2 acres) during construction, and B-P Build Alternative 2 would affect the smallest area (4,502.6). B-P Build Alternatives 1 and 5 would both affect 4,586.7 acres. The CCNM Design Option would affect 3.6 more acres of soils with moderate erosion potential during construction for each B-P Build Alternative. The Refined CCNM Design Option would affect 701.8 more acres of soils with moderate erosion potential during construction for each B-P Build Alternative. The LMF/MOWF/MOIS facilities would affect 25.7 more acres for B-P Build Alternative 2 and 30.8 more acres for B-P Build Alternatives 1, 3 and 5 during construction. If exposed soils are not protected from wind or water erosion, both the exposed work area and any stockpiles could erode and cause indirect impacts on air and water quality. Increased surface water runoff could also result from the construction of temporary, impermeable work surfaces.

Project construction would include implementation of 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 (BMP) Field Manual and Troubleshooting Guide* (Caltrans 2003a), in order to reduce the potential for erosion. Project design would include GEO-IAMF1 and GEO-IAMF#10, which require preparation of a construction management plan that addresses specific geologic constraints, including soil erosion, and issuance of a TM documenting how engineering guidelines and standards have been incorporated, respectively.

Upper layers of soil can contain cemented zones and hardpan that can be very difficult to excavate with conventional machinery. Excavations in these types of soils are relatively common, and contractors are familiar with methods to handle excavations in hardpan. Project construction would include the use of methods in the *Caltrans Construction Site Best Management Practices (BMPs) Manual* (Caltrans 2003b) and the *Construction Site Best Management Practice (BMP) Field Manual and Troubleshooting Guide* (Caltrans 2003a), such as pre-drilling using rock bits for drilled piers/piles or the use of backhoe-mounted hydraulic impact hammers for shallow excavations. Project design would include GEO-IAMF#1 and GEO-IAMF#10 to minimize risks associated with difficult excavation, which require preparation of a construction management plan addressing geologic constraints, and incorporation of engineering guidelines and standards, respectively.

All of the B-P Build Alternatives except B-P Build Alternative 2 would result in construction activities occurring on 370.7 acres of oil fields. B-P Build Alternative 2 would result in in construction activities occurring on 345.6 acres, which is the smallest area of all the B-P Build Alternatives. There would be no change in the number of acres of oil fields affected with the CCNM Design Option and Refined CCNM Design Option. The LMF/MOWF/MOIS Facilities under B-P Build Alternative 2 will result in construction activities occurring on 13.3 more acres of oil fields, and under B-P Build Alternatives 1, 3, and 5 will result in construction activities occurring on 18.4 more acres of oil fields. Alternative 2 would have the most oil wells located within the construction footprint (21 oil wells), followed by B-P Build Alternative 3, which would have 19 oil wells. B-P Build Alternatives 1 and 5 would have 18 oil wells, which is the smallest amount. There will be no changes in the amount of oil wells B-P Build Alternatives are located on with implementation of the CCNM Design Option and Refined CCNM Design Option. There is also a potential for off-gassing from inactive or abandoned wells within the Edison Oil Field. However, the alignment is not in a tunnel and does not have any deep cuts in this section. The Phase II fieldwork would include further investigation of the potential for off-gassing. Additionally, portions of the B-P Build Alternatives may overlie radon deposits, which could potentially represent a hazard to HSR buildings in the portion of the alignment in the Tehachapi Mountains. Project design would include GEO-IAMF#3, which includes compliance with strict federal and state regulatory requirements, as well as safe practices and regular gas testing during construction.

The hazards from abandoned mines are dependent on the type of material mined, the depth and extent of the mine workings, and groundwater conditions. Mine collapse would be of concern to HSR workers during construction. Prior to construction, planned LiDAR surveys would aid in the detection of abandoned mine shafts and mine tailings. Project design would include GEO-IAMF#4, which addresses steps to mitigate hazards associated with abandoned mines. These measures could include CERCLA and non-CERCLA cleanup in the event that abandoned mines are found, as well as safety mitigation to remove dangerous structures.

The presence of naturally occurring hazardous minerals, such as asbestos and mercury, would be of concern for workers during construction. The project design includes GEO-IAMF#5, which requires submittal of a hazards management plan that outlines steps taken to minimize or avoid impacts related to hazardous minerals, such as dust control, control of soil erosion and water runoff, and testing and proper disposal of excavated material.

The potential for impacts from unstable soils during project operation is the same as that described for project construction, except that the exposure period increases. With the longer exposure period, the potential for creep- or groundwater-related soil failures increases. Project design would include GEO-IAMF#1 and GEO-IAMF#10 to minimize risks associated with unstable soils during operation, by requiring preparation of a construction management plan that addresses specific geologic constraints and issuance of a TM documenting how engineering guidelines and standards have been incorporated, respectively.

Soil settlement could occur during project operation due to regional subsidence. Soil settlement could also occur on a local scale at locations where soft deposits of silty or clay soils are subjected to new earth loads, as might occur with approach fills for elevated guideways, or for track subgrade and ballast materials placed to meet track grade requirements. The potential consequence of excessive settlement represents a high risk to HSR travel if unaddressed. However, regional subsidence and localized settlement are typically slow processes that, with periodic maintenance, are remediable. Project design would include GEO-IAMF#1 and GEO-IAMF#10, which require preparation of a construction management plan describing how the contractor would address specific geologic constraints, and implementation of standards of design and building code requirements to provide either sufficient bearing capacity and slope stability or measures that protect the facility from loads associated with unstable soils, respectively. Additionally, GEO-IAMF#9 provides a subsidence monitoring program that includes track inspection systems that provide early warning of reduced track integrity.

While all of the B-P Build Alternatives would be on soils with moderate to high expansive potential, B-P Build Alternative 3 would be on the largest area (320.4 acres) and Alternative 2 would be on the smallest area (299 acres). B-P Build Alternatives 1 and 5 would be on 300.9 acres. Implementation of the CCNM Design Option would increase the number of acres of soils with expansive potential by 3.6 acres for each B-P Build Alternative and the Refined CCNM Design Option would increase the number of acres of soils with expansive potential by 99.1 acres for each B-P Build Alternative. The potential for shrink-swell soils, if unchecked, represents a risk to the operation of the track system and the track right-of-way for long-term operations. This type of impact is more critical to locations with at-grade segments than to elevated structures on deep foundations. The earth loads associated with at-grade segments of the B-P Build Alternatives may not be sufficient to overcome shrink-swell potential, and this swell would likely be variable along the alignment, leading to differential movement of the track system. Special engineering or construction considerations would be necessary where the B-P Build Alternatives traverse expansive soils. Project design would include GEO-IAMF#10, which includes geotechnical engineering guidelines and standards that would minimize the hazards related to expansive soils. These standards include a subsurface drilling and laboratory testing program. Additionally, specific methods, such as those discussed in GEO-IAMF#1e, would address constraints identified in the project construction management plan. Methods include mixing soil additives with existing soil to reduce shrink-swell potential.

While all of the B-P Build Alternatives would be on soils with moderate to high corrosive potential to concrete, B-P Build Alternative 3 would be on the largest area (650.9 acres) and B-P Build Alternative 2 would be on the smallest area (586.1 acres). B-P Build Alternatives 1 and 5 would be on 595.2 acres. Implementation of the CCNM Design Option would not change the number of acres of land with corrosive potential to concrete that the B-P Build Alternatives would be on; however, implementation of the Refined CCNM Design Option would increase the area of land with corrosive potential to concrete that the B-P Build Alternatives are on by 245.4 acres.

All of the B-P Build Alternatives would also be on soils with moderate to high corrosive potential to steel, B-P Build Alternative 3 would be on the largest area (7,116.2 acres) and B-P Build Alternative 5 would be on the smallest area (7,033.8 acres). B-P Build Alternatives 1 and 2 would be on 7,092.7 acres and 7,036.0 acres, respectively. The CCNM Design Option would not change the number of acres of soils corrosive to concrete for each B-P Build Alternative. It would, however, increase the number of acres of soils corrosive to steel for each of the B-P Build Alternatives by 23.4 acres. The Refined CCNM Design Option would increase the number of acres of soils corrosive to steel that the B-P Alternatives will be on by 677.5 acres. The potential for corrosion to uncoated steel and concrete represents a significant risk to the long-term operation of the track system and the track right-of-way, including the eventual loss in the structural capacity of buried steel or concrete components. Where buried concrete or steel portions of the project structures would be located in areas with potentially corrosive soils, the soils would be analyzed by standard geotechnical engineering testing and soil resistivity surveys to identify the extent of the problem. Project design would include GEO-IAMF#1, which requires preparation of a construction management plan to address identified constraints with methods such as the removal of soils with corrosive potential and the utilization of corrosion-protected materials in infrastructure.

Slopes along some rivers and streams could fail, either from additional earth loads at the top of the slope, undercutting by stream erosion at the toe of the slope, or additional seismic forces during a seismic event. The consequences of slope failure would be either loss of bearing support to the track facilities or increased load on structures in the path of the slope failure. The former represents a higher risk because of the flat topography along the B-P Build Alternatives. Loss in bearing support would affect at-grade sections more than cut sections and elevated structures supported on deep foundations. These failures could endanger people and on- and off-site structures in the event of damage to the HSR track. A Registered Engineering Geologist would conduct detailed slope stability evaluations and the project design would include GEO-IAMF#1, which requires preparation of a construction management plan to address identified constraints. Project design would also address slope stability by incorporating standard IBC and other engineering standards and criteria, including those outlined in GEO-IAMF#10. Additionally, per GEO-IAMF#2, the operation and maintenance procedures would include slope monitoring by a Registered Engineering Geologist.

The entire length of the alignment in the B-P Project Section is within Seismic Zone 4 (1 in 10 chance that an earthquake with an active peak acceleration level of 0.40g will occur in the next 50 years). The level of ground shaking could vary along the alignment, depending on the amount of ground motion amplification or deamplification within specific soil layers. However, the likely level of seismically induced ground motion is enough to cause damage regardless of the specific location. Project design would include GEO-IAMF#7, which requires preparation of a TM outlining how all B-P Project Section components were evaluated and designed for large seismic ground shaking. The B-P Project Section design would address the train's performance by specifically evaluating the response of the track system, confirming that the soil provides sufficient support to the track, and specifying minimum seismic loading requirements for elevated structures.
The project would use elevated structures supported on deep foundations that are designed for movement and shear forces associated with ground shaking of a certain magnitude, as outlined in TM 2.10.4 (Authority 2009a). In addition, GEO-IAMF#8 would include the installation of a network of instruments to provide ground motion data for use with the HSR instrumentation and controls system to temporarily shut down B-P B Project Section operations in the event of an earthquake. Installation of train derailment containment devices would take place in sections across hazardous fault zones as a track safety precaution. The guidelines and standards outlined in GEO-IAMF#10 and in *TM 2.9.10: Geotechnical Analysis and Design Guidelines* would address further design considerations for seismic ground shaking.

B-P Build Alternative 3 travels through 4.98 miles of fault zones, which is the most among the B-P Build Alternatives, while B-P Build Alternative 5 travels through 4.91 miles, which is the least. B-P Build Alternatives 1 and 2 travel 4.93 and 4.95 miles, respectively. The CCNM Design Option does not change the number of times the B-P Build Alternatives would traverse fault zones, but it does reduce the area that each B-P Build Alternative would cross the Tehachapi Creek Fault by 1.51 acres. The Refined CCNM Design Option increases the number of times the B-P Build Alternatives would traverse fault zones, and increases the area that each B-P Build Alternative would cross the Edison Fault Zone by 0.1 mile under B-P Build Alternative 2 and by 0.4 mile under B-P Build Alternatives 1, 3, and 5. Surface fault rupture is a possible problem at the locations where the B-P Build Alternatives cross the White Wolf and the Garlock faults, known hazardous faults. At these discrete locations in the B-P Build Alternatives' alignments where the B-P Project Section would intersect mapped fault traces, specialized engineering design considerations would be necessary to minimize the impacts of surface fault rupture (Authority 2009a, 2010). No tunneling would take place at these fault crossings or in Alquist-Priolo Earthquake Fault Zones. TM 2.9.3, TM 2.9.6, and the standards and guidelines outlined in GEO-

IAMF#10 would incorporate engineering design considerations pertaining to surface fault rupture. Evaluation of the potentially hazardous faults that the B-P Project Section crosses or comes close to—the Edison, Tehachapi Creek, and Willow Springs faults—would take place to confirm that these faults have not ruptured the ground surface during Holocene time. While ground rupture along active faults can rarely be fully mitigated, implementation of early warning systems (GEO-IAMF#6) triggered by ground motion can aid in monitoring movement at fault crossings. In addition, the project would include installation of linear monitoring systems to temporarily control traffic and trains, and avoid accidents in the event of ground rupture. Damage from fault creep detected through monitoring would be mitigated with routine maintenance such as repaving or realignment. Additionally, implementation of GEO-IAMF#8 would result in the suspension of operations during an earthquake and confirmation of acceptable conditions before service resumes.

Liquefaction in the RSA may occur at stream crossings in the Tehachapi Valley, in Lancaster, and near the Palmdale Station. All of the B-P Build Alternatives would be on 22.5 acres with both seismic hazard and liquefaction risk, with the exception of the CCNM Design Option, which would reduce the number of acres by 0.1 acre for all B-P Build Alternatives. The Refined CCNM Design Option would increase the number of acres by 8.5 for all B-P Build Alternatives on land with both seismic hazard and liquefaction risk. B-P Build Alternative 3 would be on the largest area with high potential for liquefaction (231.5 acres) and B-P Build Alternative 5 would be on the smallest area (229.5 acres). B-P Build Alternatives 1 and 2 would be on 229.6 acres. The CCNM Design Option would reduce the number of acres for all B-P Build Alternatives on areas of liquefaction risk by 8.5 acres, whereas the Refined CCNM Design option would increase the number of acres for all B-P Build Alternatives located on areas of liquefaction risk by 72.4 acres. Overall, the LMF/MOWF/MOIS facilities would increase the number of acres for all B-P Build Alternatives located on areas of both seismic hazard/liquefaction risk and only liquefaction risk by 12.4 acres.

At locations where groundwater and soil foundation conditions are favorable with respect to development of strength loss from liquefaction, deep foundations typically provide structural support through liquefied layers. Lateral spreading is anticipated in localized areas throughout the B-P Project Section, such as at selected stream crossings and areas south of the Palmdale Station. At these select locations, the impacts of lateral spreading would be addressed by conventional engineering design consisting of ground improvement or a structural solution. Project design would include GEO-IAMF#10, which requires a TM documenting how geotechnical engineering guidelines and standards have been incorporated into facility design and construction. In addition, GEO-IAMF#1 would require preparation of a construction management plan, which would outline how the contractor would address specific geologic constraints and hazards, such as liquefaction and lateral spreading.

Detailed slope-stability evaluations and implementation of engineering measures, such as ground improvement, use of retaining walls, or regrading of slopes, as appropriate, would reduce the potential for seismically induced landslides. Project design would include GEO-IAMF#2, which would incorporate slope monitoring by a Registered Engineering Geologist into the operation and maintenance procedures.

The dams that could potentially fail and result in inundation of the B-P Project Section are Lake Isabella Dam and Blackburn Dam. All of the B-P Build Alternatives would be on 350.3 acres of inundation zones except Alternative 3, which would be on the largest area (353 acres). There would be no change to the acreage of the Lake Isabella Dam or Blackburn Inundation Zone for each B-P Build Alternative with the CCNM Design Option; however, there would be a reduction of 7.35 acres if the Refined CCNM Design Option is implemented. There would be a 12.4 acre reduction for each B-P Build Alternative on land designated as a dam inundation zone with implementation of the LMF/MOWF/MOIS facilities. A seismically induced dam failure at Lake Isabella Dam or Blackburn Dam is unlikely because the seismic event would need to be large enough to cause catastrophic damage to the dam structure. Due to the HSR system being near the limit of the Lake Isabella Dam inundation area, it is also anticipated that there would be sufficient time for evacuation in the event of catastrophic dam failure. Additionally, flows from Blackburn Dam would move east toward Proctor Lake.

3.9.8.2 Paleontological Resources

Table 3.9-16 provides a comparison of the effect of the B-P Build Alternatives (including the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street) on paleontological resources. The B-P Build Alternatives incorporate IAMFs that would avoid or minimize effects associated with paleontological resources during construction. These IAMFs would include features for eliminating any potential direct impact on paleontological resources by requiring paleontological monitoring and procedures, should construction activities uncover fossils. None of the B-P Build Alternatives (including the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street) would impact paleontological resources during operation as excavations and similar ground disturbance would only take place during the construction phase. The impacts of the No Project Alternative would be minimal and comparable to those predicted for the B-P Build Alternatives.

Table 3.9-16 Comparison of B-P Build Alternative Impacts for Paleontological Resources

Impact	Alternative 1	Alternative 2	Alternative 3	Alternative 5	CCNM Design Option	Refined CCNM Design Option	LMF/MOWF/ MOIS Facilities
Construction							
Impact Paleo #1: Geologic Units Sensitive to Unknown Paleontological Resources During Construction							
Geologic Units with “High” Paleontological Sensitivity	8.9 miles	8.9 miles	8.35 miles	8.9 miles	-0.02 mile	No change	No change
Geologic Units with “High at Depth” Paleontological Sensitivity	48.32 miles	48.32 miles	47.4 miles	48.32 miles	No change	No change	No change

Source: California High-Speed Rail Authority, 2019
Because the CCNM Design Option and the Refined CCNM Design Option are variations on the common alignment of Alternatives 1, 2, 3, and 5 in the Keene area, impacts are presented as being either greater (+) or less than (-) the values presented above for Alternatives 1, 2, 3, and 5.
B-P = Bakersfield to Palmdale Project Section
CCNM = César E. Chávez National Monument
LMF/MOWF/MOIS Facilities = Light Maintenance Facility/Maintenance-of-Way Facility/Maintenance-of-Infrastructure Siding Facility

Construction activity associated with the development of any of the B-P Build Alternatives (including the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street) would disturb geologic units with “high” and “high at depth” (at or below 5 feet) paleontological sensitivity that could yield scientifically significant paleontological resources. B-P Build Alternatives 1, 2, and 5 cross approximately 8.9 miles of geologic units with “high” paleontological sensitivity and 48.32 miles of geologic units with “high at depth” paleontological sensitivity (i.e., areas mapped as Holocene alluvium at the surface), resulting in the largest area of disturbance to geologic units that could yield scientifically significant paleontological resources. B-P Build Alternative 3 crosses 8.35 miles of geologic units with “high” paleontological sensitivity and 47.4 miles of geologic units with “high at depth” paleontological sensitivity, resulting in the smallest area of disturbance to geologic units that could yield scientifically significant paleontological resources. The CCNM Design Option and Refined CCNM Design Option would not change the number of miles of geologic units of “high” paleontological sensitivity or geologic units with “high at depth” paleontological sensitivity for each B-P Build Alternative. The project design would include implementation of GEO-IAMF#15, GEO-IAMF#12, GEO-IAMF#13, GEO-IAMF#14, and GEO-IAMF#15, which would eliminate any potential direct impact of any of the B-P Build Alternatives on paleontological resources by requiring paleontological monitoring and procedures should construction activities uncover fossils.

3.9.9 CEQA Significance Conclusions

3.9.9.1 Geology, Soils, and Seismicity

Table 3.9-17 provides a summary of the CEQA determination of significance for all geology, soils, and seismicity construction and operations impacts discussed in Section 3.9.6.3.

Table 3.9-17 Summary of CEQA Significance Conclusions and Mitigation Measures for Geology, Soils, and Seismicity

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Construction			
Impact GSS#1: Encountering Unstable Soils During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#2: Soil Settlement at Structures or Along Trackway During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#3: Soil Erosion During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#4: Difficult Excavations Due to Bedrock and Hardpan During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#5: Potential Exposure to Hazardous Gas During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Impact GSS#6: Potential Encounters with Abandoned Mines During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#7: Potential Exposure to Hazardous Minerals During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Operations			
Impact GSS#8: Effects of Unstable Soils during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#9: Effects of Soil Settlement during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#10: Effects of Moderate to High Shrink-Swell Potential during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#11: Effects of Moderately to Highly Corrosive Soils during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Impact GSS#12: Effects of Slope Failure during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA t from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities
Impact GSS#13: Effects of Seismicity during Operations	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities	N/A	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities

B-P = Bakersfield to Palmdale Project Section
CCNM = César E. Chávez National Monument
F-B LGA = Fresno to Bakersfield Locally Generated Alternative
N/A = not applicable

3.9.9.2 Paleontological Resources

Table 3.9-18 provides a summary of the CEQA determination of significance for all paleontological resources construction impacts discussed in Section 3.9.6.3.

Table 3.9-18 Summary of CEQA Significance Conclusions and Mitigation Measures for Paleontological Resources

Impact	Level of Significance before Mitigation	Mitigation Measure	Level of Significance after Mitigation
Construction			
Impact Paleo #1: Geologic Units Sensitive to Unknown Paleontological Resources During Construction	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, and the LMF/MOWF/MOIS facilities.	N/A for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, and the LMF/MOWF/MOIS facilities. The following measures apply to the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street: F-B LGA CUL-MM #16, : F-B LGA CUL-MM #17, and : F-B LGA CUL-MM #18.	Less than Significant for all the B-P Build Alternatives, the CCNM Design Option, the Refined CCNM Design Option, the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street, and the LMF/MOWF/MOIS facilities. Less than significant after mitigation for the portion of the F-B LGA from the intersection of 34th Street and L Street to Oswell Street.

[1] Per Section 3.9 of the *Fresno to Bakersfield Section Draft Supplemental EIR/EIS* (Authority and FRA 2017), under the Impact GSSP#12 discussion, the level of significance for impacts on paleontological resources for the portion of the F-B LGA between the 34th Street and L Street intersection to Oswell Street was potentially significant before mitigation measures were prescribed. However, IAMFs GEO-IAMF#15, GEO-IAMF#12, GEO-IAMF#13, GEO-IAMF#14, and GEO-IAMF#15, GEO-IAMF#9, GEO-IAMF#2, GEO-IAMF#7, GEO-IAMF#8, and GEO-IAMF#6 in this Draft EIR/EIS reflect the same requirements and would be applied to all of the B-P Build Alternatives, including the portion of the F-B LGA between the 34th Street and L Street intersection and Oswell Street.
F-B LGA = Fresno to Bakersfield Locally Generated Alternative
B-P = Bakersfield to Palmdale
N/A = not applicable
CCNM = César E. Chávez National Monument

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