Chapter 8
Geology, Soils, and Paleontological Resources

8.1 Introduction

This chapter describes the environmental setting for regional geology and seismic hazards, soil conditions, and paleontological resources within the project area. It also presents the state and local policies and regulations that determine mitigation requirements; identifies impacts related to geologic, soil, and paleontological resources that may result from implementation of the proposed project; and identifies mitigation measures to reduce these impacts where necessary. The following sources of information were reviewed to prepare this chapter:

- Capital SouthEast Connector Geotechnical Impact Report (Parsons Brinckerhoff 2010a; Appendix D)
- Capital SouthEast Connector Environmental Screening Analysis Final Technical Report (URS Corporation 2006)
- Sacramento County General Plan (Sacramento County 1993)
- El Dorado County General Plan (El Dorado County 2004)
- Elk Grove General Plan (City of Elk Grove 2009)
- Folsom General Plan (City of Folsom 1993)
- Rancho Cordova General Plan (City of Rancho Cordova 2006a)

8.2 Environmental Setting

8.2.1 Existing Conditions

The project alignment is relatively flat, with approximate elevations of 13 feet at the south end and 700 feet at the north end. The alignment is underlain by thick Quaternary and Tertiary alluvial deposits that originated from millennia of erosion of materials from the west slopes of the Sierra Nevada. Although the mountainous areas to the west are seismically active, the Central Valley is considered to be relatively seismically stable.

8.2.1.1 Regional Physiographic Setting

The project area is situated within two geomorphic provinces: the Great Valley Geomorphic Province to the west and Sierra Nevada Geomorphic Province to the east (California Geological Survey 2002). The Great Valley of California, also called the Central Valley, is a nearly flat alluvial plain extending from the Tehachapi Mountains in the south to the Klamath Mountains in the north, and from the Sierra Nevada in the east to the Coast Ranges in the west. The valley is about 450 miles long and averages about 50 miles wide. Elevations of the alluvial plain are generally just a few hundred feet above mean sea level (MSL), with extremes ranging from a few feet below MSL to about 1,000 feet above MSL (Hackel 1966).

The Sierra Nevada is a strongly asymmetric mountain range with a long gentle western slope and a high, steep eastern escarpment. The range averages 50 to 80 miles wide, and it runs west to north through eastern California for more than 400 miles, from the Mojave Desert to the south to the Cascade Range and Modoc Plateau to the north (Bateman and Wahrhaftig 1966).

8.2.1.2 Project Area Geology and Topography

The project alignment is located in an area of fairly flat topography in the Central Valley. It is underlain by five major geologic units: a metamorphic and igneous basement complex, consolidated marine deposits, consolidated volcanic rocks, continental deposits, and unconsolidated older alluvium. Near-surface deposits consist of thick Quaternary alluvial fan and river floodplain deposits derived from fluvial systems originating from higher elevations to the east. The younger geologic units affect the project area most directly and include dredge tailings, recent river channel and floodplain deposits, and the older Quaternary Victor, Riverbank, and Laguna Formations. Below the Laguna Formation are Secondary and Tertiary Metamorphic Rocks (Sacramento Water Resources Investigation 1973 in Appendix D). Aggregate and oil/gas reserves are present in the study area; one oil well and several aggregate mining operations are located in the project area (Figure 4 in Appendix D).

8.2.1.3 Seismicity

Seismic hazards are earthquake fault ground rupture and ground shaking (primary hazards), and liquefaction and earthquake-induced slope failure (secondary hazards). Compared to other areas of the state (e.g., the San Francisco Bay region), the project area is not located in a very seismically active region. However, with respect to ground shaking, earthquakes have occurred in the vicinity of the project area and can be expected to occur again. The nearest fault system is located approximately 9 miles east of the northern terminus of the project and is part of the Foothills fault system (Figure 3 in Appendix D).

Surface Rupture and Faulting

California’s Alquist-Priolo Earthquake Fault Zoning Act (PRC 2621 et seq.) is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults and strictly regulates construction in the corridors along active faults (earthquake fault zones). It also defines criteria for identifying active faults, giving legal weight to terms such as *active*, and establishes a process for reviewing building proposals in and adjacent to earthquake fault zones.

Faults identified in an Alquist-Priolo earthquake fault zone are typically active faults. As defined under the Alquist-Priolo Act, an active fault has had surface displacement within Holocene time (about the last 11,000 years). An early Quaternary fault has had surface displacement during Quaternary time (the last 1.6 million years). A pre-Quaternary fault has had surface displacement before the Quaternary period.

The project area is not identified as being located in an Alquist-Priolo earthquake fault zone (Hart and Bryant 1997), and the Uniform Building Code (UBC) recognizes no seismic sources in the Sacramento region (International Conference of Building Officials 1997). However, numerous early Quaternary and pre-Quaternary faults associated with the Foothills fault system are located in the project vicinity. Most of these faults are early Quaternary in nature and have not had significant movement during the last 10,000 years. However, many areas of late Cenozoic faulting and some areas of Quaternary faulting have been identified along this system.

Ground-Shaking Hazard

The measurement of the energy released at the point of origin, or epicenter, of an earthquake is referred to as the *magnitude*, which is generally expressed using Richter or moment magnitude. The scale used in the Richter magnitude is logarithmic, so each successively higher Richter magnitude reflects an increase in the energy of an earthquake of about 31.5 times.

Moment magnitude is the estimation of an earthquake magnitude by using seismic moment, a measure of an earthquake size using rock rigidity, amount of slip, and area of rupture. The greater the energy released from the fault rupture, the higher the magnitude of the earthquake. Earthquake energy is most intense at the fault epicenter; the farther an area is from an earthquake epicenter, the less likely that ground shaking will occur there. Geologic and soil units comprising unconsolidated, clay-free sands and silts can reach unstable conditions during ground shaking, which can result in extensive damage to structures built on them (see "Liquefaction and Related Hazards" below).

Ground shaking is described by two methods: ground acceleration as a fraction of the acceleration due to gravity (g) or the Modified Mercalli scale, a more descriptive method involving 12 levels of intensity denoted by Roman numerals. Modified Mercalli intensities range from I (shaking that is not felt) to XII (total damage).

As mentioned above, the project area is located in a region of California characterized by historically low seismic activity and low ground-shaking hazard. Based on a probabilistic seismic hazard map that depicts the peak horizontal ground acceleration values exceeded at a 10% probability in 50 years (Cao et al. 2003; in Appendix D), the probabilistic peak horizontal ground acceleration value in the project area is about 0.22, where 1 g equals the force of gravity, thus indicating that the ground-shaking hazard in the project area is low.

The project area is located in UBC Seismic Hazard Zone 3. In these zones, structures must be designed with the load-bearing capacity to meet the regulations and standards associated with Zone 3 hazards.

8.2.1.4 Liquefaction and Related Hazards

Liquefaction is a phenomenon in which the strength and stiffness of unconsolidated sediments are reduced by earthquake shaking or other rapid loading. Poorly consolidated, water-saturated fine sands and silts that have low plasticity and are located within 50 feet of the ground surface are typically considered the most susceptible to liquefaction. Soils and sediments that are not water-saturated and that consist of coarser or finer materials are generally less susceptible to liquefaction (California Division of Mines and Geology 1997). Based on the sedimentological characteristics of the soils and the depth to groundwater, liquefaction hazard is expected to be moderate for the project area.

Two potential ground failure types associated with liquefaction in the Great Valley Geomorphic Province are lateral spreading and differential settlement (Association of Bay Area Governments 2001). Lateral spreading involves a layer of ground at the surface being carried on an underlying layer of liquefied material over a gently sloping surface toward a river channel or other open face. Lateral spreading is common in the Great Valley Geomorphic Province and poses a moderate to significant hazard (Association of Bay Area Governments 2001). Differential settlement (also called ground settlement and, in extreme cases, ground collapse) occurs as soil compacts and consolidates after ground shaking ceases. It occurs when the layers that liquefy are not of uniform thickness, which is common when the liquefaction occurs in artificial fills. Settlement can range from 1% to 5%, depending on the cohesiveness of the sediments (Tokimatsu and Seed 1984).

8.2.1.5 Landslides

Within the limits of the project area, the risk of naturally occurring large landslides varies depending on slope, underlying geology, surface soil strength, and moisture in soil. Significant excavation, grading, or fill work during construction might introduce landslide hazards along the project alignment. Because the project alignment is flat and no significant excavation is planned at this point, the potential for direct impact from landslides is considered low.

8.2.1.6 Soils

Geographic Relationships and Distribution of Soils in Major Land Resource Areas

Because of the large size of the project area, characterization of soils has been inferred using major land resource area (MLRA) information. An MLRA is a geographically associated land resource unit (LRU). An LRU is a geographic area, usually several thousand acres, characterized by a particular pattern of soil, climate, water resources, and land use. A unit can be a continuous area or several separate nearby areas. An LRU is the basic unit from which an MLRA is determined. It is also the basic unit for state land resource maps. It is coextensive with state general soil map units, but some general soil map units are subdivided into LRUs because of significant geographic differences in climate, water resources, and land use (Natural Resources Conservation Service 2006). The project area is located within MLRA 17. Descriptions of soil texture and erosion, runoff, and expansion hazards are described for the surface horizon of the soils only (Figure 8-1).

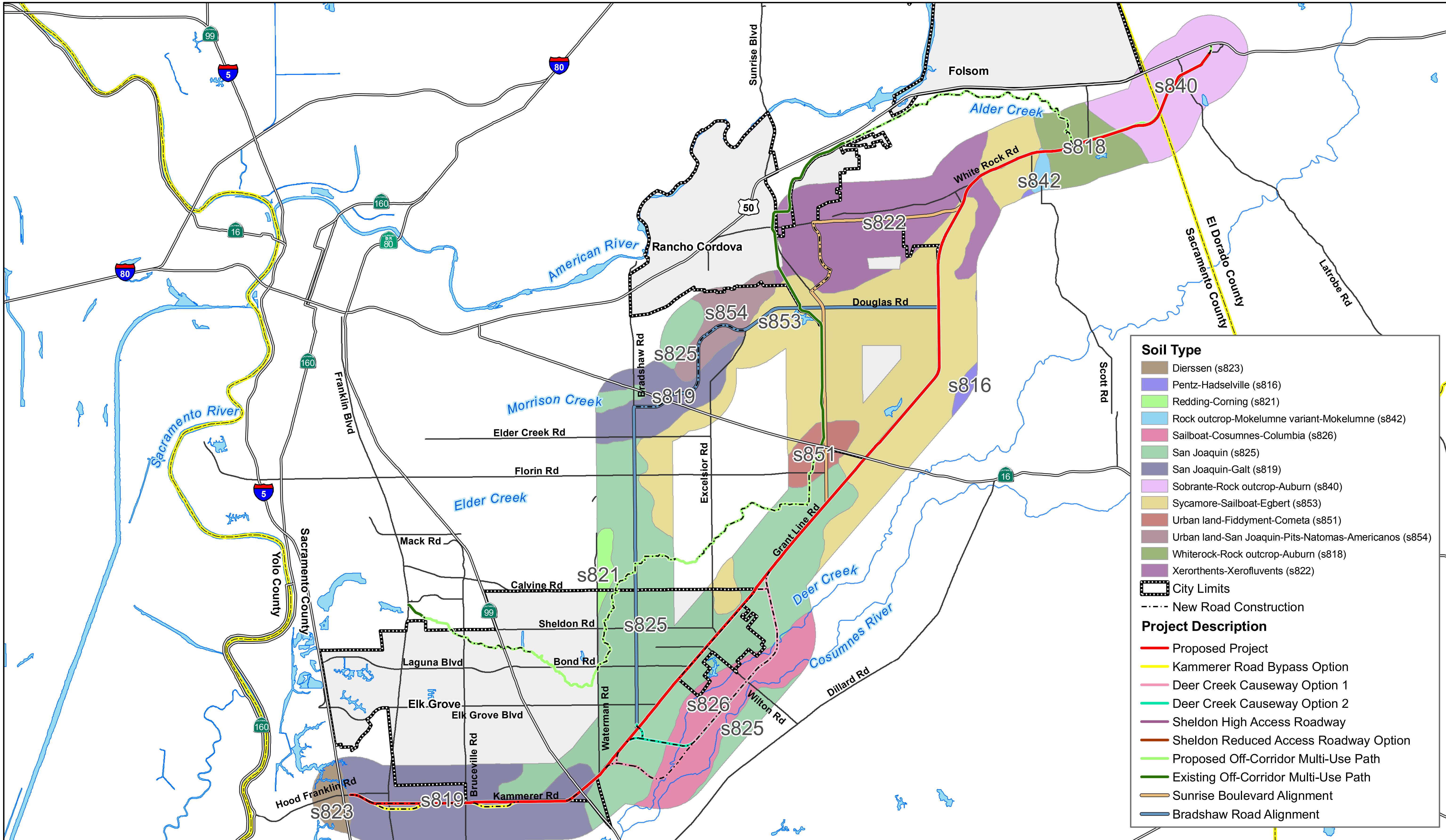
The western portion of the project area is located within MLRA 17, the Sacramento and San Joaquin Valleys. The soils are nearly level and are alluvial, occurring on low terraces, fans, floodplains, and basins. Soil textures are generally clayey to loamy sand. Soils in the northern portion of the study area are organic. Soils are very deep. Erosion hazard is slight to none, runoff is very slow, and soil expansiveness is low to high, depending on geographic location and texture.

Expansive Soils

Expansive soils shrink and swell with wetting and drying. The shrink-swell capacity of expansive soils can result in differential movement beneath foundations/pavements. Based on Sacramento County soil survey data, the project alignment is mainly underlain by San Joaquin silt in lowlands near the south end and sand/gravel/dredge tailings from mining activity/loam in the higher elevations near the north end (Natural Resources Conservation Service 2006). In addition, the depth to water is shallow and significant shrink-swelling would not be expected. Based on this information, the likelihood of expansive soils to be present at the site is low (Natural Resources Conservation Service 2006).

Tsunami, Seiches, and Flooding

The project alignment is not located near large bodies of water, so the threat of tsunami, seiches, or other seismically induced flooding is unlikely.



Data Layers Provided by Sacramento County GIS Department, Sacramento County Planning Department, SACOG, El Dorado County, El Dorado County Planning Department, The US Fish and Wildlife Service, and USGS

CAPITAL | SOUTHEAST CONNECTOR Connecting Communities

PB PSOMAS ICF INTERNATIONAL

Soil Types

Figure 8-1

Plot Date
January 27, 2011

K:\Projects_1\parsons_brinckerhoff\00907_08\mapdoc\Figures\Figure_Project_Safety_Facilities_20100908_93.mxd ds (1/27/2011)

Naturally Occurring Asbestos

Asbestos is a commercial term used to identify a group of six silicate minerals (chrysotile, crocidolity, amosite, tremolite, actinolite, and anthophyllite) that are fibrous and contain several properties that made them very useful in manufactured products and industrial processes during the 20th century. In addition to the silicate group above, some amphiboles such as richterite and winchite are known or suspected of being a health risk (Appendix D). Because of health concerns related to asbestos exposure, the use of asbestos has decreased significantly. Asbestos is regulated by state, federal, and international regulatory agencies based on its classification as a known human carcinogen. Naturally occurring asbestos in the vicinity of the project area is addressed in Chapter 4, "Air Quality."

8.2.1.7 Paleontological Resources

Paleontology is a science that looks at the life of past geological periods as known from fossil remains. Paleontological resources include fossil remains, as well as fossil localities and formations that have produced fossil material in other nearby areas. These resources can be important educational resources, and are they are not renewable once destroyed. Geologic history and conditions are relevant to the evaluation of paleontological resources because they influence the type of fossils that may be found (i.e., aquatic vs. terrestrial organisms) and the probability that any prehistoric remains would be subject to fossilization rather than normal decay. The depositional history of the Sacramento Valley during the late Quaternary included several cycles related to fluctuations in regional and global climate that caused alternating periods of deposition followed by periods of subsidence and erosion. Therefore, the Sacramento Valley during the Pleistocene consisted of stages of wetlands and floodplain creation as tidewaters rose in the valley from the west, areas of erosion when tidewaters receded, and alluvial fan deposition from streams emanating from the adjacent mountain ranges (Atwater 1982).

A search of the University of California Museum of Paleontology collections database [1] identified several locations within Sacramento County and El Dorado County where paleontological resources have been found, including fossils recovered from the Teichert mining operation in the study area vicinity. The finds date primarily to the late Pleistocene and include fish, frogs, snakes, turtles, and plants. Other fossil remains have included bison, horse, camel, mammoth, ground sloth, and wolf.

8.2.2 Regulatory Setting

8.2.2.1 Federal

Clean Water Act 402/National Pollutant Discharge Elimination System

The CWA is discussed in detail in Chapter 10, "Hydrology and Water Quality." However, because CWA Section 402 is directly relevant to excavation, additional information is provided below.

Amendments in 1987 to the CWA added Section 402(p), which establishes a framework for regulating municipal and industrial stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) program. The EPA delegated the authority for the NPDES program in California to the SWRCB, which is implemented by the state's nine RWQCBs. Under the NPDES Phase

[1] University of California Museum of Paleontology. 2010. Berkeley Natural History Museums. Collections search. Available: http://ucmpdb.berkeley.edu/Browse_US_states2.html. Access date: October 10, 2010.

II Rule, construction activity disturbing 1 acre or more must obtain coverage under the state's General Construction Permit (Order 2009-0009-DWQ). General Construction Permit applicants are required to prepare a notice of intent and a storm water pollution prevention plan (SWPPP), and to implement and maintain BMPs to avoid releasing sediment and contaminants into surface waters as a result of construction activities, including earthwork. The SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the Section 303(d) list for sediment.

International Building Code

The design and construction of engineered facilities in California must comply with the requirements of the International Building Code (IBC) (International Code Council 2006) and the adoptions to that code adopted by the State of California (see "California Building Standards Code" below).

8.2.2.2 State

Seismic Hazards Mapping Act

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (PRC 2690–2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong ground shaking, liquefaction, and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the State of California is charged with identifying and mapping areas at risk of strong ground shaking, liquefaction, landslides, and other corollary hazards, and cities and counties are required to regulate development within mapped seismic hazard zones.

Under this act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites in seismic hazard zones until appropriate site-specific geologic or geotechnical investigations have been carried out, and measures to reduce potential damage have been incorporated into the development plans. Geotechnical investigations conducted within seismic hazard zones must incorporate standards specified by California Geological Survey Special Publication 117 (California Division of Mines and Geology 1997).

California Building Standards Code

The State of California's minimum standards for structural design and construction are set forth in the California Building Standards Code (CBSC) (24 CCR). The CBSC is based on the IBC, which is used widely throughout United States (generally adopted on a state-by-state or district-by-district basis) but has been modified for California conditions with numerous, more detailed or more stringent regulations. The CBSC requires that "classification of the soil at each building site will be determined when required by the building official" and that "the classification will be based on observation and any necessary test of the materials disclosed by borings or excavations." In addition, the CBSC states that "the soil classification and design-bearing capacity will be shown on the (building) plans, unless the foundation conforms to specified requirements." The CBSC provides standards for various aspects of construction, including excavation, grading, and earthwork construction; fills and embankments; expansive soils; foundation investigations; and liquefaction potential and soil strength loss. In accordance with California law, certain aspects of the proposed project would be required to comply with all provisions of the CBSC.

The California Building Code (CBC) requires extensive geotechnical analysis and engineering for grading, foundations, retaining walls, and other structures, and include criteria for seismic design.

Paleontological Resources

No state or local agencies have specific jurisdiction over paleontological resources. However, CEQA Guidelines Section 15064.5(a)(3) provides protection for paleontological resources by requiring that they be identified and mitigated as historical resources. PRC 21000 et seq. requires public agencies and private interests to identify the potential adverse effects or environmental consequences of their proposed projects to any object or site important to the scientific annals of California (Division 1, PRC 020.1[b]). This is interpreted to include fossils and other paleontological resources.

8.2.2.3 Local

Geotechnical Investigations

Local jurisdictions in the project area typically regulate construction activities through a process that may require conducting a site-specific geotechnical investigation. The purpose of a site-specific geotechnical investigation is to provide a geologic basis for the development of appropriate construction design. Geotechnical investigations typically assess bedrock and Quaternary geology, geologic structure, soils, and the previous history of excavation and fill placement for design of earthworks and foundations for proposed structures.

Local Grading and Erosion Control Ordinances

The counties and cities in the project area have grading and erosion control ordinances. These ordinances are intended to control erosion and sedimentation caused by construction activities. A grading permit is typically required for construction-related projects. As part of the permit, project applicants usually must submit a grading and erosion control plan, vicinity and site maps, and other supplemental information. Standard conditions in the grading permit include a description of BMPs similar to those contained in a SWPPP.

General Plans

Cities and counties have stated goals, objectives, and policies in their respective general plans related to geology, soils, and paleontology. The proposed project must comply with the goals, objectives, and policies stated in these plans. Table 8-1 lists the specific general plan elements and sections that apply to geology, soils, and paleontology in the project area.

Table 8-1. Applicable Local General Plans

Jurisdiction	Document	Section
El Dorado County	General Plan (2004)	Land Use and Conservation and Open Space Elements
Sacramento County[a]	General Plan (1993)	Land Use and Conservation Elements
City of Elk Grove	General Plan (2009)	Historic Resources and Conservation and Air Quality Elements
City of Folsom	General Plan (1993)	Land Use Element
City of Rancho Cordova	General Plan (2006a)	Cultural and Historic Resources and Natural Resources Elements

Sources: City and county general plans as noted.
[a] Sacramento County is in the process of adopting a comprehensive general plan update.

8.3 Impact and Mitigation Discussion

8.3.1 Thresholds of Significance

Appendix G of the State CEQA Guidelines provides guidance for evaluation of project effects on geology, soils, and paleontological resources. Based on these guidelines, the proposed project would have a significant impact if it would:

- expose people or structures to rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo earthquake fault zoning map issued by the state geologist for the area or based on other substantial evidence of a known fault;
- expose people or structures to major geologic hazards that could result in loss, injury, or death related to strong seismic ground shaking or seismic-related ground failure, including liquefaction or landslides;
- result in development on a geologic unit or soil that is unstable or that would become unstable as a result of the proposed project and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse;
- result in substantial soil erosion or the loss of topsoil;
- result in development on expansive soil, as defined in the UBC (International Conference of Building Officials 1997), creating substantial risks to life or property; or
- directly or indirectly destroy a unique paleontological resource or site or unique geologic feature.

8.3.2 Approach and Methodology

The evaluation of the geology, soils, and paleontology impacts assumes that the JPA or local agency will ensure that the project design and construction conforms to the latest IBC standards, CBSC standards, Caltrans seismic design criteria, county and city general plan seismic standards, county and city grading ordinances, and NPDES requirements, as appropriate for site-specific project components.

8.3.3 Impacts of the Proposed Project

This section describes potential impacts on geology, soils, and paleontological resources that could result from the project and mitigation to reduce these effects.

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

Ground rupture is caused when an earthquake event along a fault creates rupture at the surface. No known active faults exist in the project vicinity. The proposed project will need to be designed and constructed to withstand moderate to strong earthquake-shaking as specified in Caltrans Standards or 2007 CBC for Seismic Zone 3. Therefore, the risk of fault rupture is low. This impact is less than significant. No mitigation is necessary.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

The project area is located in a region with low potential for ground shaking. The proposed project will need to be designed and constructed to withstand moderate to strong earthquake-shaking as specified in Caltrans Standards or 2007 CBC for Seismic Zone 3. Therefore, the risk of fault rupture is low. This impact is less than significant. No mitigation is necessary.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. However, the geotechnical investigation determined that soil types in the study area may be conducive to liquefaction. The impact is considered significant. Mitigation Measures GEO-1 and GEO-2, which include implementing the recommendations of the geotechnical investigation to conduct site-specific geotechnical investigations, would reduce this impact to a less-than-significant level.

Mitigation Measure GEO-1: Implement Seismic Design Standards into Site-Specific Project Design

Prior to construction, the JPA or local jurisdictions will ensure that the project is designed and constructed in compliance with the latest CBSC standards, Caltrans seismic design criteria, and county and city general plan seismic standards to ensure that all project components can withstand moderate to strong earthquake-shaking.

Mitigation Measure GEO-2: Conduct Site-Specific Geotechnical Investigations and Implement the Recommendations

Prior to construction, the JPA or local jurisdictions will prepare project-specific geotechnical investigations to guide the design of earthworks and foundations for proposed structures. Based on the subsurface conditions expressed through geotechnical investigation, the JPA and local jurisdictions, in conjunction with soil scientists or engineers, will ensure that specific project elements are designed to accommodate the effects of liquefaction of expansive soils. For roadways and bridges, subsurface borings at regular intervals along proposed roadways and in the vicinity of proposed bridges are recommended as part of the geotechnical evaluations.

If the site-specific geotechnical investigations find that liquefiable soils, soils susceptible to seismically induced settlement, or expansive soils are present at any location where project activities would occur, corrective actions will be taken. These actions may include—depending on the extent and depth of susceptible soils and findings of the geotechnical evaluations—removal and replacement of soils; on-site densification; grouting; and design of special foundations or other similar measures. All of these measures reduce pore water pressure during ground shaking by making the soil more dense or improving its drainage capacity (Johansson 2000). The JPA or local jurisdictions will ensure that their contractors implement one or more of these measures in consultation with a qualified engineer before beginning and during construction.

The JPA or local jurisdictions will ensure, as a contract specification, that their contractors implement the recommendations of site-specific geotechnical reports pertaining to site clearing and preparation, organic removal, engineered fill placement, trench backfilling, foundation design, soundwall systems, exterior flatwork, pavement design, and site drainage to minimize any adverse effects associated with runoff, erosion, and sedimentation.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

The shrink-swell capacity of expansive soils can result in differential movement beneath foundations/pavements. Although the likelihood of expansive soils in the study area is low, if present beneath planned project components, they could compromise the structural integrity of proposed new facilities (including roadways, bridges, and associated features). This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2, which include implementing the recommendation of the geotechnical investigation to conduct site-specific geotechnical investigations, would reduce this impact to a less than significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Grading, excavation, removal of vegetation cover, and loading activities associated with construction activities could temporarily increase runoff, erosion, and sedimentation. Construction activities also could result in soil compaction and wind erosion effects that could adversely affect soils and reduce the revegetation potential at construction sites and staging areas. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. Improvements and modifications occurring within existing rights-of way would have less potential to encounter previously unknown resources relative to those in undisturbed areas; however, any work entailing deep ground disturbance would have the potential to encounter paleontological resources. This is considered a significant impact. Mitigation Measure GEO-3 would reduce this impact to a less than significant level.

Mitigation Measure GEO-3: Stop Work if Paleontological Resources are Discovered During Construction and Implement Recommendations of Paleontologist

If paleontological resources (i.e., fossils) are discovered during ground-disturbing activities, the JPA or local jurisdictions will ensure that their contractors notify the JPA or local jurisdictions responsible for project implementation, and stop work in that area and within 100 feet of the find until a qualified paleontologist can assess the significance of the find and develop appropriate treatment measures. Treatment measures will be made in consultation with the JPA or local jurisdictions and would include the following steps to be taken by a qualified paleontologist:

- Conduct a paleontological survey of the area before continuing with construction.
- If construction could encounter significant paleontological resources, monitor construction in the area for the purpose of ensuring that construction does not destroy resources before they can be evaluated
- Salvage, curate, and preserve significant paleontological resources to meet professional standards.

8.3.4 Impacts of the Off-Corridor Multi-Use Path Alternative

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

There are no known active faults in the project vicinity and the risk of fault rupture is low. This impact is less than significant.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

There are no known active faults in the project vicinity and the risk of groundshaking is low. This impact is less than significant.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. This impact is considered significant. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

Although the likelihood of expansive soils is low, if present in the study area, they could compromise the structural integrity of proposed new facilities. This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Construction activities could temporarily increase runoff, erosion, and sedimentation or result in soil compaction and wind erosion effects. This alternative would require construction of large areas of new pathway, often near existing drainages and creeks, thereby increasing the potential for these effects. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. Additionally, portions of this alternative would require construction of new pathway, thereby increasing the potential for damage or destruction of unique paleontological resources, although the depth of construction would be less than roadway construction. The impact would be significant. As described above, Mitigation Measure GEO-3 would reduce this impact to a less than significant level.

8.3.5 Impacts of the Project Options

There would not be any additional adverse effects on geology, soils or paleontology as a result of any of the design options. Likewise, no geologic or seismic factors are anticipated to have adverse effects on any of the design options. There is no differentiation between the design options with respect to geologic or seismic conditions.

8.3.5.1 Kammerer Road Bypass Option

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

There are no known active faults in the project vicinity and the risk of fault rupture is low. The impact is less than significant.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

There are no known active faults in the project vicinity and the risk of groundshaking is low. The impact is less than significant.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. This impact is considered significant. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

Although the likelihood of expansive soils is low, if present in the Kammerer Bypass area, they could compromise the structural integrity of proposed new facilities (including roads). This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Construction activities could temporarily increase runoff, erosion, and sedimentation or result in soil compaction and wind erosion effects. Portions of this option would require construction of new roadway, thereby increase the potential for these effects. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. Additionally, portions of this option would require construction of new roadway, thereby increasing the potential for damage or destruction of unique paleontological resources. The impact would be significant. As described above, Mitigation Measure GEO-3 would reduce this impact to a less than significant level.

8.3.5.2 Deer Creek Causeway Options

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

There are no known active faults in the project vicinity and the risk of fault rupture is low. This impact is less than significant.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

There are no known active faults in the project vicinity and the risk of groundshaking is low. This impact is less than significant.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. This impact is considered significant. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Implementation of this option would not reduce or avoid any impacts of the proposed project.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

Although the likelihood of expansive soils is low, if present in the study area, they could compromise the structural integrity of proposed new facilities. This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Construction activities could temporarily increase runoff, erosion, and sedimentation or result in soil compaction and wind erosion effects. This option would require major construction across Deer Creek and within the Cosumnes River watershed, thereby increasing the potential for these effects. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. Additionally, this option would require construction of new roadway segments and installation of deep buried support structures for above-grade components, thereby increasing the potential for damage or destruction of unique paleontological resources. The impact would be significant. As described above, Mitigation Measure GEO-3 would reduce this impact to a less than significant level.

8.3.5.3 Sheldon Reduced Access Roadway Option

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

There are no known active faults in the project vicinity and the risk of fault rupture is low. This impact is less than significant.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

There are no known active faults in the project vicinity and the risk of groundshaking is low. This impact is less than significant.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. This impact is considered significant. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

Although the likelihood of expansive soils is low, if present in the study area, they could compromise the structural integrity of proposed new facilities. This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Construction activities could temporarily increase runoff, erosion, and sedimentation or result in soil compaction and wind erosion effects. This option could require construction some new roadway, thereby increasing the potential for these effects. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant. Implementation of this option would not reduce or avoid any impacts of the proposed project.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. The impact would be significant. As described above, Mitigation Measure GEO-3 would reduce this impact to a less than significant level.

8.3.5.4 Sheldon High Access Roadway Option

Impact GEO-1: Potential Structural Damage and Injury Caused by Fault Rupture

There are no known active faults in the project vicinity and the risk of fault rupture is low. This impact is less than significant.

Impact GEO-2: Potential Structural Damage and Injury from Ground Shaking

There are no known active faults in the project vicinity and the risk of groundshaking is low. This impact is less than significant.

Impact GEO-3: Potential Structural Damage and Injury from Development on Materials Subject to Liquefaction

Based on the low existing ground-shaking hazard, sediment characteristics of the soils, and depth to groundwater, the liquefaction hazard to construction workers and users of project facilities is expected to be moderate. This impact is considered significant. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-4: Potential Structural Damage as a Result of Development on Expansive Soils

Although the likelihood of expansive soils is low, if present in the study area, they could compromise the structural integrity of proposed new facilities. This is considered a significant impact. As described above, Mitigation Measures GEO-1 and GEO-2 would reduce this impact to a less-than-significant level.

Impact GEO-5: Potential Accelerated Runoff, Erosion, and Sedimentation from Construction Activities

Construction activities could temporarily increase runoff, erosion, and sedimentation or result in soil compaction and wind erosion effects. This option could require construction some new roadway, thereby increasing the potential for these effects. This is considered a significant impact. However, the JPA or local jurisdictions will require grading and construction contractors to comply with the applicable county or city grading ordinances as a contract specification, which would minimize any adverse effects associated with erosion and sedimentation. Mitigation Measure HYD-1: Obtain and Implement the Requirements of the NPDES Construction General Permit, described in Chapter 10, Hydrology and Water Quality, would further reduce the impact to less than significant. Implementation of this option would not reduce or avoid any impacts of the proposed project.

Impact GEO-6: Potential for Damage to or Destruction of Previously Undiscovered Buried Paleontological Sites

Project construction and staging activities could disturb buried, undiscovered paleontological sites. The impact would be significant. As described above, Mitigation Measure GEO-3 would reduce this impact to a less than significant level.