3.13 Geology, Seismicity, and Soils

This supplemental environmental impact report (SEIR) addresses proposed modifications to the B.F. Sisk Dam Safety of Dams Modification Project, which was previously evaluated in the B.F. Sisk Dam Safety of Dams Modification Project Environmental Impact Statement/Environmental Impact Report (2019 EIS/EIR). The project addressed in the 2019 EIS/EIR is referred to herein as the Approved Project; the Approved Project with proposed modifications identified since certification of the 2019 EIS/EIR is referred to herein as the Modified Project.

This section describes the existing geology and soil conditions associated with the Modified Project site and vicinity, identifies associated regulatory requirements, evaluates potential impacts, and identifies any applicable mitigation measures related to the implementation of the Modified Project.

3.13.1 Existing Conditions

3.13.1.1 Regional Geology

The Modified Project site is located along the boundary of the Great Valley and Coast Ranges Geomorphic Provinces, two of the dominant structural features in California. The Coast Ranges Province is a mountainous, northwest-trending region that extends approximately 500 miles in a north–south direction, ranging from the Transverse Ranges Province (in the south) to the Oregon border. In the vicinity of the Modified Project site, the Coast Ranges are expressed as the easternmost extension of the Diablo Range foothills. Conversely, the Great Valley Province is an alluvial plain about 50 miles wide and 400 miles long in Central California. The Great Valley is geologically monotonous and forms a trough in which sediments have been deposited almost continuously since the Jurassic period (about 160 million years ago) (CGS 2002a). The Great Valley represents the alluvial, flood, and delta plains of its two major waterways, the Sacramento and San Joaquin Rivers (CGS and CDPR 2015).

The boundary between the Coast Ranges and Great Valley Provinces near the Modified Project area is roughly delineated by the Ortigalita Fault and O'Neill Fault Zones, which pass underneath and to the south of San Luis Reservoir and O'Neill Forebay (Figure 3.13-1, Regional Faulting). The Ortigalita Fault separates the Upper Cretaceous marine bedrock units and Plio-Pleistocene non-marine alluvial fan and basin deposits of the Great Valley Sequence (located to the east of the fault) from the Upper Jurassic/Lower Cretaceous Franciscan Assemblage bedrock units of the Diablo Range foothills (located to the west of the fault) (CGS 2020a).

3.13.1.2 Site Topography

The additional impact areas of the Modified Project are located (1) immediately downstream of the central and southern base of the dam (i.e., the additional staging and stockpiling areas); (2) within approximately 0.5 miles downstream of the southern portion of the dam (i.e., Borrow Areas 12 and 14); and (3) on the west shore of O'Neill Forebay (i.e., the proposed campground and existing San Luis Creek Day Use Area) (Figure 3.13-2, Geologic Map).

The embankment of the dam is steeply to moderately sloping, undulating, and sparsely vegetated. A concrete-lined spillway conduit of the dam is located within the northern portion of the embankment, immediately east of the Gianelli Pumping-Generating Plant (Figure 2-4A, Modified Project Detail). The northwestern and western shoreline of O'Neill Forebay, in the vicinity of the proposed campground and existing San Luis Creek Day Use Area, consists of relatively flat-lying areas adjacent to the shoreline, with gentle to moderately sloping hillsides along the western portions of these additional impact areas.

Southeast of the dam embankment, Borrow Area 12 consists of an approximately 28-acre grassland hillside that is about 100 feet higher than the surrounding lower-lying area (Figure 3.13-2). The top of Borrow Area 12 is relatively flat, having been used in the past as a borrow area for the initial construction of the dam. The adjoining (to the south) 200-acre Borrow Area 14 encompasses four grassland hills, which are up to 200 feet higher than the downstream base of the dam. The topography of Borrow Area 14 primarily includes gentle to moderate slopes, with localized areas of moderately steep slopes.

Near the southern shoreline of San Luis Reservoir, south of Basalt Road, the Modified Project area consists of moderately to steeply sloping, undulating, sparsely vegetated hillsides. North of Basalt Road, near the southeastern shoreline of the Reservoir, the Modified Project area consists of low-lying flat topography (Figure 2-4B, Figure 3.13-2).

3.13.1.3 Geologic Units

The following summarizes the geologic units that underlie the Modified Project area.

Artificial Fill

As illustrated on Figure 3.13-2, the B.F. Sisk Dam embankment consists of artificial fill deposits, which were derived in part from the Modified Project area, including Borrow Area 12 and the Basalt Hill Borrow Area.

Landslide Deposits

Numerous large Quaternary-age (past 1.6 million years) landslide deposits radially emanate from Basalt Hill, in the southern portion of the Modified Project area, upslope of a proposed staging and stockpiling area (Figure 3.13-2). Although the headscarps of these landslides primarily occur within Tertiary basalt deposits, most of the landslides occur in shale deposits of the Cretaceous-age Panoche Formation, as described below (Dibblee 2007).

Alluvium

Holocene (past 11,700 years) alluvium, consisting of relatively unconsolidated gravel, sand, and clay, is present in flat-lying areas of the Modified Project area, including portions of the proposed campground, portions of the existing San Luis Creek Day Use Area, canyon bottoms within Borrow Area 14, and portions of an additional staging and soil stockpiling area near Basalt Hill (Figure 3.13-2) (Dibblee 2007).

Panoche Formation

Cretaceous-age (65 to 145 million years ago) bedrock of the Panoche Formation underlies most of the eastern shoreline of San Luis Reservoir and portions of the dam embankment (Figure 3.13-2). This formation consists primarily of sandstone, shale, and lenses of coarse-grained conglomerates, consisting of boulders, cobbles, and pebbles of porphyritic[1] and granitic rock (Dibblee 2007; Scheirer and Magoon 2007). In the Modified Project area, the dam embankment and additional staging and stockpiling areas on the downstream side of the dam are primarily underlain by conglomerate (presumably including beneath the alluvium, based on the bedding orientation). Shale, with lesser amounts of conglomerate, underlie portions of the proposed campground and existing San Luis Creek Day Use Area. Shale and sandstone primarily underlie Borrow Areas 12 and 14; and shale deposits underlie a portion of the additional staging and stockpiling area near Basalt Hill (Dibblee 2007).

[1] A rock that has a distinct difference in the size of the crystals, with at least one group of crystals obviously larger than another group.

3.13.1.4 Soils

The following summarizes the soil units that underlie the Modified Project area.

Oneil Silt Loam

Oneil silt loam is present in areas of Panoche Formation shale and sandstone, as described above, including much of the existing San Luis Creek Day Use Area, and Borrow Areas 12 and 14 (Figure 3.13-2). This soil unit is present on hillsides, ranging from 8% to 50% slopes, and is derived from weathered sandstone and shale. These soils are well-drained, with medium to high runoff capacity (USDA 2020).

Oquin Fine Sandy Loam

Oquin fine sandy loam is present in areas of alluvium in the vicinity of the proposed campground, adjacent to O'Neill Forebay (Figure 3.13-2). This soil unit is present on gently sloping areas, with gradients of 2% to 8%, and is derived from calcareous sandstone. These soils are well-drained, with low runoff capacity (USDA 2020).

Wisflat-Rock Outcrop-Arburua Complex

Wisflat-Rock outcrop-Arburua complex is present in the western portion of the proposed campground area, overlying Panoche Formation sandstone and shale (Figure 3.13-2). This soil type is present on hillsides with 30% to 50% gradients and is derived from sandstone and shale. These soils are well-drained, with a medium runoff capacity (USDA 2020).

Xerofluvents, Extremely Gravelly

The proposed additional staging and stockpiling area located adjacent to the Gianelli Pumping-Generating Plant is underlain by Xerofluvents (Figure 2-4A, Modified Project Detail). This soil type typically consists of gravelly alluvium at the base of slopes, is poorly drained, with low runoff capacity (USDA 2020).

Ballvar Loam

The proposed additional staging and stockpiling areas at the southern end of the dam (Figure 3.13-2) are underlain by Ballvar loam. These soils are generally located on alluvial fans, on 2% to 8% slopes, are well-drained, with a high runoff capacity (USDA 2020).

3.13.1.5 Seismicity and Faulting

The Modified Project area is in a seismically active region. Several large and well-known faults are located near the Modified Project area, and movement along those faults, most notably the San Andreas Fault Zone, has greatly influenced the erosional and depositional history of the area (Figure 3.13-1). The faults closest to the Modified Project area are the Ortigalita and O'Neill Fault Zones. Other significant faults in the region include the Calaveras Fault Zone, San Joaquin Fault, and Quien Sabe Fault.

The California Geological Survey (CGS) (2018a) classifies faults as follows:

- Holocene-active faults: faults that have demonstrated surface displacement during the past approximately 11,700 years (i.e., Holocene time). These faults exhibit signs of geologically recent movement, are most likely to experience movement in the near future, and are capable of surface rupture. These faults are also considered "active faults." In addition, Holocene-active faults that have demonstrated surface displacement in the last 200 years can be further classified as "historic faults."
- Pre-Holocene faults: faults that have not demonstrated surface displacement in the past 11,700 years (Holocene) but have moved during the past 130,000 years (late Quaternary) or 1.6 million years (Quaternary undifferentiated). These faults are also considered "potentially active faults" and may be capable of surface rupture but are less likely than Holocene-active faults to cause surface rupture. These faults are also capable of generating future earthquakes.
- Age-undetermined faults: faults where the recency of fault movement has not been determined. These faults are also considered "inactive faults."

Holocene-active faults have been responsible for large historical earthquakes in Central and Northern California, including the 1868 Hayward earthquake (estimated moment magnitude [Mw] 6.9); the 1906 San Francisco earthquake (estimated Mw 7.9); and the 1989 Loma Prieta earthquake (Mw 6.9).

Most of the Holocene-active faults in California are manifested as fault zones. Fault zones are defined as a region, varying in width from yards to miles, that is bounded by major faults within which subordinate faults may be arranged variably or systematically. For example, the San Andreas Fault Zone is a region of crushed and broken rock, varying in width from a few hundred feet to a mile wide. Many smaller faults branch from and join the San Andreas Fault Zone (USGS 2016). Faults in proximity to the Modified Project site are listed in Table 3.13-1. Distances from the additional impact areas of the Modified Project site to individual faults represent the distance to the nearest fault segment within the respective fault zones.

Table 3-13-1. Regional Faulting

Regional Faulting	Approximate Closest Distance to the Modified Project Site (miles)	Fault Age	Probable Magnitude (Mw)[2]
Ortigalita Fault Zone	0.5	Holocene-active	6.9
O'Neill Fault Zone	1.0	Late-Quaternary	Undetermined
San Joaquin Fault	5.0	Holocene-active	Undetermined
Quien Sabe Fault	17.0	Holocene-active	6.4
Calaveras Fault Zone	21.0	Holocene-active	6.8
San Andreas Fault Zone	28.0	Holocene-active	7.2–7.4

Source: USGS 2020a; CGS 2020; Caltrans 2001; Johnson 2013.

San Andreas Fault Zone

The Holocene-active San Andreas Fault extends for about 680 miles along the western margin of California. This fault is located near the coast in Northern California but traverses inland portions of the state to the south

[2] Moment magnitude (Mw) is a measure of earthquake magnitude (size or strength) based on seismic energy. Magnitudes are based on a logarithmic scale (base 10), indicating that for every whole number increase on the magnitude scale, recorded ground motion increases 10 times in strength. Probable magnitude is the estimated magnitude of a given fault if it were to activate.

of San Francisco (Figure 3.13-1), extending to the Salton Sea in Imperial County. The San Andreas Fault is the defining element of a network of right-lateral faults that constitute the San Andreas Fault System, which collectively accommodates most of the relative north–south motion between the Pacific and North American plates (USGS 2020a).

Many large and historical earthquakes have occurred on active faults associated with the regional stress field of the San Andreas Fault System. In addition, the San Andreas Fault has generated significant damaging earthquakes in 1838 and 1865, as well as the Great San Francisco Earthquake of 1906 (USGS 2020a). Expected seismic magnitudes vary between each segment of the San Andreas Fault. The closest fault segment of the San Andreas Fault to the additional impact areas of the Modified Project area is the Creeping section, which is located approximately 28 miles to the southwest and has the potential to generate between a Mw 7.2 to 7.4 earthquake (Johnson 2013; CGS 2020). According to a 2008 Earthquake Rupture Forecast Study by the Working Group on California Earthquake Probabilities (WGCEP), the San Andreas Fault has a 59% chance of generating a Mw 5.0 or more within the next 30 years (WGCEP 2008).

Ortigalita Fault Zone

The Holocene-active Ortigalita Fault Zone is a major north–northwest-striking, right-lateral strike-slip fault, which is an eastern extension of the San Andreas Fault System. Near the Modified Project area, the Ortigalita Fault Zone delineates the boundary between the Franciscan Assemblage of the Diablo Range from the geologic formations in the Great Valley Sequence (Figure 3.13-1) (USGS 2020a). Two distinct geometric sections of the fault are located near the Modified Project site, including the Los Banos Valley and Cottonwood Arm sections (Figure 3.13-3, Local Faulting). A 3.1-mile-wide right-step separates the segments across San Luis Reservoir (Caltrans 2001). The Los Banos Valley section of the fault is approximately 0.7 miles west of the Basalt Hill Borrow Area of the Approved Project, while the Cottonwood Arm section transects Basalt Campground (Figure 2-4B), approximately 0.5 miles east and west of a proposed staging/stockpiling area and additional temporary haul road, respectively (Figure 3.13-3) (CGS 2020). The maximum considered seismic event for the Ortigalita Fault is an Mw 6.9 earthquake, with an effective recurrence interval of 1,100 years (Caltrans 2001).

O'Neill Fault Zone

The Late-Quaternary O'Neill Fault Zone consists of three northwest–southeast-trending faults that strike toward O'Neill Forebay. The westernmost extension of the fault extends into O'Neill Forebay, transecting Borrow Area 6 of the Approved Project (Figure 3.13-3). At its closest point, the fault is approximately 1.0 mile to the east of the San Luis Creek Day Use Area, near the western shoreline of O'Neill Forebay (CGS 2020).

Calaveras Fault Zone

The right-lateral, Holocene-active Calaveras Fault is a major branch of the San Andreas Fault System. The Calaveras Fault extends from the eastern San Francisco Bay region into the western Diablo Range before eventually joining the San Andreas Fault. This fault is located approximately 21 miles to the southwest of the Modified Project area and is capable of producing a Mw 6.8 earthquake (Figure 3.13-1) (CGS 2020; USGS 2020a). According to a 2008 Earthquake Rupture Forecast Study by WGCEP, the Calaveras Fault has a 7% chance of generating a Mw 5.0 or more earthquake within the next 30 years (WGCEP 2008).

San Joaquin Fault

The Holocene-active San Joaquin Fault Zone is an east-dipping reverse fault located to the southeast of O'Neill Forebay (Herd 1979). At its closest point, the fault is approximately 5.0 miles to the northeast of the Modified Project site (Figure 3.13-1) (CGS 2020).

Quien Sabe Fault

The Holocene-active, right-lateral Quien Sabe Fault is approximately 14 miles long and bounds the southwestern portion of the Diablo Range (USGS 2020a). The fault is approximately 17 miles to the southwest of the Modified Project site and is capable of producing an Mw 6.4 earthquake (Figure 3.13-1) (CGS 2020; Caltrans 2001).

3.13.1.6 Ground Shaking

Ground shaking is the movement of the Earth surface as a result of an earthquake. Ground motion produced by seismic waves emanates from slow or sudden slip on a fault. The degree of ground shaking felt at a given site depends on the distance from the earthquake source, the magnitude of the earthquake, the type of subsurface material on which the site is situated, and topography. Generally, ground shaking is less severe on rock than on alluvium or fill, but other local phenomena may override this generalization. Ground shaking can produce significant ground horizontal and vertical movement that can result in severe damage to structures that are generally not equipped to withstand such ground movement.

While there have been no recorded instances of major earthquakes originating in Merced County, there has been documented shaking from earthquake centers outside the county in 1872, 1906, 1952, 1966, 1984, and 1989. Only the 1906 quake caused major damage in the county. In addition, minor seismic structural damage has occurred throughout Merced County on other occasions (Merced County 2012).The Earthquake Rupture Forecast Study by WGCEP (2008) indicates a 93% probability of a Mw 6.7 or greater earthquake, and a 16% probability of a Mw 7.5 or greater earthquake occurring within the next 30 years in Northern California. A separate WGCEP (2003) report indicates a 62% probability for a Mw 6.7 or greater earthquake within the next 30 years in the San Francisco Bay Area Region. Individual faults with the highest earthquake probabilities cited in the 2008 report are the Hayward/Rodgers Creek, San Andreas, and Calaveras Faults (Merced County 2012).

3.13.1.7 Surface Rupture

Surface rupture involves the displacement and cracking of the ground surface along a fault trace. Surface ruptures are visible instances of horizontal or vertical displacement, or a combination of the two, typically confined to a narrow zone along the fault. Surface rupture is more likely to occur in conjunction with active fault segments where earthquakes are large, or where the location of the movement (earthquake hypocenter) is shallow.

The Alquist-Priolo Earthquake Fault Zoning Act of 1972 (Alquist-Priolo) regulates development near Holocene-active faults to mitigate the hazard of surface fault rupture. This act requires the State Geologist to establish regulatory zones (known as Alquist-Priolo Special Study Fault Zones) around the surface traces of Holocene-active faults and to issue appropriate maps. Local agencies must regulate most development projects within the zones. Before a project can be permitted, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults. A licensed geologist must prepare an evaluation and written report of a specific site. If a Holocene-active fault is found, a structure for human occupancy cannot be placed over the trace of the fault and must be set back from the fault.

The Modified Project site is located with the CGS 7.5-minute San Luis Dam Quadrangle. According to the State of California Special Studies Zones, the Modified Project is not located with an Alquist-Priolo Fault Zone. The closest such zones are associated with the Los Banos Valley and Cottonwood Arm sections of the Ortigalita Fault (Figure 3.13-3). At the closest point, the Alquist-Priolo Fault Zone associated with the Cottonwood Arm section of the Ortigalita Fault is located approximately 1.3 miles west of the Modified Project site (CDMG 1986; CGS 2016).

3.13.1.8 Liquefaction

Liquefaction is a process in which loose, saturated granular soil loses strength as a result of cyclic loading.[3] The strength loss is a result of a decrease in granular sand volume and a positive increase in pore pressures. Generally, liquefaction can occur if all of the following conditions apply: liquefaction-susceptible soil, groundwater within a depth of 40 feet or less, and strong seismic ground shaking. Soils that are most susceptible to liquefaction are clay-free deposits of sands and silts, and unconsolidated alluvium. In addition, lateral spreading—a hazard associated with liquefaction—is the finite, lateral movement of gently to steeply sloping, saturated soil deposits caused by earthquake-induced liquefaction.

The CGS has mapped areas of potential liquefaction for select U.S. Geological Survey quadrangles, but not for the San Luis Dam quadrangle. The Merced Vision 2030 General Plan Revised Background Report indicates that no liquefaction hazard areas have been identified within the county. However, the potential for liquefaction still exists throughout the San Joaquin Valley due to unconsolidated sediments and high water tables (Merced County 2013a). In addition, groundwater levels are typically high near-surface water bodies, such as San Luis Reservoir and O'Neill Forebay. As such, given the potential high water table, areas of unconsolidated Holocene alluvium, and proximity to Holocene-active faults (e.g., Ortigalita Fault, San Joaquin Fault), there is a potential for on-site seismic ground failure due to liquefaction, including lateral spreading, in the Modified Project site, including the proposed campground, existing San Luis Creek Day Use Area, and the additional staging/stockpiling area near the Basalt Hill Borrow Area (Figure 3.13-2).

3.13.1.9 Slope Instability

A landslide is the downhill movement of masses of earth material under the force of gravity. The stability of a slope, or the potential for slope movement to occur, is dependent on many factors, including the height of the slope, the shear strength of rock and/or soil that comprises the slope, the orientation of bedding planes in underlying geologic formations, and the amount of water contained in the slope material. These and many other factors influence the stability of a slope, but in general, sandy or granular soils and rock units are stronger and less likely to be associated with large-scale landsliding than are soil and rock units composed of fine-grained silt or clay.

The down-slope movement of earth material is part of the continuous and natural process of erosion; however, the stability of a slope can be adversely affected by a wide variety of factors, such as adding water to a slope. Other factors that can decrease the stability of a slope include erosion of the toe of the slope, which removes support from the overlying material; placing addition additional weight on the slope; changes to the slope configuration by grading; earthquake-related ground-shaking; and the removal of vegetation from the surface of the slope.

Slope instability is greatest in the western part of Merced County, where the significantly higher topographic areas of the Coast Range are more susceptible to failure. As mapped by Merced County, the Modified Project areas is in a low landslide potential zone (Merced County 2012). However, as indicated on Figure 3.13-2, the topography in

[3] Cyclic loading is the application of repeated or fluctuating stresses, strains, or stress intensities on structural components.

the southern Modified Project area is locally steep and numerous large Quaternary landslides radially emanate from Basalt Hill, including upslope from a proposed staging and stockpiling area (Dibblee 2007). Moderately steep hillsides are also present in Borrow Area 14; however, no landslides have been mapped in these areas.

In September 1981, a 1,100-foot section of the upstream B.F. Sisk Dam embankment, near the crest of the dam, slid about 60 feet. The landslide, which consisted of 400,000 cubic yards of soil, was a deep-seated failure that extended through the fill material and into the native soil under the dam. The main mass of the dam remained stable and the reservoir was not threatened. Remedial measures consisted of construction of a buttressing berm at the upstream toe of the dam and reconstruction of the upstream face (Schuster 2006; California Water Research 2017).

3.13.1.10 Soil Erosion

Soil erosion occurs when wind, water, or ground disturbances cause soil particles to move and be deposited elsewhere. Numerous conditions influence the susceptibility of soil to the efforts of erosion, although the characteristics of the soil, vegetative cover, and topography are important factors. Soils with high clay content are generally less susceptible to erosion than soils with high sand or silt content. Soils with high organic material content are often less susceptible to erosion because the organic matter helps to bind the soil particles and absorbs water, which reduces runoff. Soils that are compacted promote higher runoff rates, which can increase off-site erosion. Soils covered with vegetation are less susceptible to erosion because the plants add organic material to the soil, shelter the soil from wind, and the plant roots bind the soil together. The removal of vegetation by construction activities can result in a substantial increase in erosion rates. Areas with steep topography are more susceptible to erosion because sloping areas generally have higher runoff water velocities, which increase the ability of water to dislodge and carry soil particles.

Increases in soil erosion rates caused by disturbances of the ground surface or other causes can result in increased sediment loads in receiving waters such as ponds, reservoirs, streams, and the ocean. Increased sediment loads can have a variety of adverse effects on water quality. In addition to impacts such as decreased water clarity, reduced light penetration, and diminished photosynthesis on aquatic plants, sediment particles can carry pollutants such as nutrients, bacteria, pesticides, metals, and hydrocarbons. These pollutants can impair water quality by promoting algae growth and associated decreases in dissolved oxygen levels and may also be toxic to aquatic organisms.

The U.S. Department of Agriculture, National Resource Conservation Service and the CGS have surveyed and classified the erosion hazard for soils through the United States. The ratings indicate the hazard of soil loss in off-road and off-trail areas after disturbance activities that expose the soil surface. The ratings are based on slope and soil erosion factor "K." Potential soil loss would be caused by sheet or rill erosion in off-road or off-trail areas where 50% to 75% of the surface has been exposed by logging, grazing, mining, or other types of disturbance (Reclamation and CDPR 2013).

The ratings are both verbal and numerical, and erosion hazard is described verbally as either "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion control measures may be needed; "severe" indicates that erosion is very likely and that erosion control measures, including revegetation of bare areas, are advised; and "very severe" indicates that substantial erosion is expected, loss of soil productivity and off-site damage are likely, and erosion control measures are costly and generally impractical (Reclamation and CDPR 2013).

According to Map 4, Erosion Hazard, of the San Luis Reservoir State Recreation Area Final Resource Management Plan/General Plan and Final Environmental Impact Statement/Environmental Impact Report, the erosion hazard of soils in the Modified Project area vary from slight to severe. The erosion hazard of soils near O'Neill Forebay, including the proposed campground and existing San Luis Creek Day Use Area, is slight to moderate. The erosion hazard of soils immediately downstream of the dam (i.e., proposed additional soil stockpiling and staging areas) is slight. The erosion hazard of soils in Borrow Areas 12 and 14 is moderate and moderate to severe, respectively. And the erosion hazard of soils along the hilly southeast shore of San Luis Reservoir is moderate to severe (Reclamation and CDPR 2013).

3.13.1.11 Expansive Soils

Expansive soils are mainly composed of clays, which increase in volume when saturated and shrink when dried. Expansive soils can cause building foundations to rise during the rainy season and fall during the dry season. If this expansive movement varies underneath different parts of a structure, foundations may crack, and structural portions of the structure may be distorted. The potential for soil to undergo shrink and swell is greatly enhanced by the presence of a fluctuating, shallow groundwater table. Changes in the volume of expansive soils can result in the consolidation of soft clays after the lowering of the water table or the placement of fill. As discussed in Section 3.13.1.3, Geologic Units, and illustrated in Figure 3.13-2, most of the Modified Project area is underlain by either alluvium or Panoche Formation, both which include clay deposits. As a result, on-site soils may be subject to soil expansion.

3.13.1.12 Subsidence

Subsidence is a gradual settling or sudden sinking of the ground surface due to removal or displacement of subsurface earth materials, usually due to the withdrawal of groundwater, oil, or natural gas, or as a result of decomposition of natural organic materials. Soils that are particularly subject to subsidence include those with high silt or clay content and/or high organic content. According to the 2030 Merced County General Plan Background Report, the Modified Project site is not located within a subsidence area (Merced County 2013a). Moreover, according to the U.S. Geological Survey Areas of Land Subsidence in California map, no recorded instances of subsidence have occurred within the Modified Project area because of groundwater pumping, peat loss, or oil extraction (USGS 2020b). As such, there is a low potential for subsidence to occur within the Modified Project site.

3.13.1.13 Soil Collapse

Collapsible soils typically occur in recently deposited Holocene soils that were deposited in an arid or semi-arid environment. Soils prone to collapse are commonly associated with artificial fill, wind-laid sands, silts, alluvial fan sediments, and mudflow sediments deposited during flash floods. These soils typically contain minute pores and voids. The soil particles may be partially supported by clay or silt, or chemically cemented with carbonates. When saturated, collapsible soils undergo grain rearrangement and water removes the cohesive (or cementing) material, resulting in a rapid, substantial settlement. An increase in surface water infiltration—such as from irrigation or a rise in the groundwater table—combined with the weight of a building or structure, can initiate settlement and cause foundations and walls to crack.

Soil consolidation testing has not been evaluated for on-site geologic units. As such, on-site units may be susceptible to settlement associated with collapsible soils.

3.13.1.14 Mineral Resources

As part of the Surface Mining and Reclamation Act of 1975, the CGS produces mineral land classification maps and reports. Part of the mineral land classification involves the mapping of aggregate availability throughout the State. Aggregate is defined as construction aggregate, which is composed of alluvial sand and gravel or crushed stone that meets standard specifications for use in Portland cement concrete or asphalt concrete (CGS 2012). The statewide map of aggregate availability shows the location of aggregate mines in Merced County; however, none are in the vicinity of San Luis Reservoir or O'Neill Forebay. In general, the mines are located southwest of Los Banos on the east side of Interstate 5 (CGS 2018b).

The CGS also maps the location of historic and active gold mines throughout California. There are no active gold mines in Merced County. Historically, active gold mines were in the eastern region of Merced County (CDMG 1998; CGS 2002b).

The California Geologic Energy Management Division (CalGEM) (formerly the Division of Oil, Gas, and Geothermal Resources) oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal energy wells. According to the CalGEM "Well Finder" Map, there is one dry hole well near the eastern edge of O'Neill Forebay, near the connection to the California Aqueduct. This well was abandoned in 1937 (CalGEM 2020).

The California Department of Conservation, Office of Mine Reclamation, maps inactive and active mines throughout the State, including the Modified Project area. These maps include the active Basalt Hill Borrow Area (Figure 3.13-2), which is operated by the California Department of Water Resources (DWR) and is included as a borrow area for the Approved Project. This quarry and four other quarries in the Modified Project area are listed in Table 3.13-2 (DMR 2016).

Table 3-13-2. Nearby Mine Sites in Merced County

Mine ID	Latitude/ Longitude	Location	Mine Name	Status	Commodity
91-24-0030	37.022222/-121.097222	South of San Luis Reservoir	Basalt Quarry – DWR Resources	Active	Rock
91-24-0024	37.000000/-120.960556	Southeast of O'Neill Forebay	San Luis Water District – Reclaimed	Reclaimed	Sand and Gravel
91-24-0035	36.991667/-120.916667	Southeast of O'Neill Forebay	Pfitzer Pit – Reclaimed	Reclaimed	Rock
91-24-0012	37.006111/-120.916111	Southeast of O'Neill Forebay	Canyon Rock Pit	Active	Sand and Gravel
91-24-0021	36.999167/-120.916667	Southeast of O'Neill Forebay	Valley Sand and Gravel	Idle	Not Reported

Source: DMR 2016.
Note: DWR = California Department of Water Resources.

Chrysotile asbestos and tremolite-actinolite asbestos occur in ultramafic rock, which is a type of metamorphic rock. The U.S. Geological Survey, CGS, and California Department of Conservation have mapped historic mines and natural occurrences of asbestos throughout California (DOC 2000; USGS and CGS 2011). While there have been no reported asbestos occurrences, former asbestos mines, or former asbestos prospects mapped in Merced County, there are known occurrences of ultramafic rock outcrops in the western part of the county. Ultramafic rock is known to occur (1) in Merced County near the border of Stanislaus County, north of San Luis Reservoir, and (2) near the border of Fresno County, to the south of the reservoir (DOC 2000; USGS and CGS 2011). However, neither of these sites are within the Modified Project site.

3.13.2 Relevant Plans, Policies, and Ordinances

3.13.2.1 Federal

Earthquake Hazards Reduction Act

In October 1977, the U.S. Congress passed the Earthquake Hazards Reduction Act to reduce the risks to life and property from future earthquakes in the United States, through the establishment and maintenance of an effective earthquake hazards reduction program. This goal was accomplished by establishing the National Earthquake Hazards Reduction Program. This program was substantially amended in November 1990 by the National Earthquake Hazards Reduction Program Act (NEHRPA), which refined the description of agency responsibilities, program goals, and objectives.

The mission of National Earthquake Hazards Reduction Program includes improved understanding, characterization, and prediction of hazards and vulnerabilities; improved building codes and land-use practices; risk reduction through post-earthquake investigations and education; development and improvement of design and construction techniques; improved mitigation capacity; and accelerated application of research results. The NEHRPA designates the Federal Emergency Management Agency as the lead agency of the program and assigns several planning, coordinating, and reporting responsibilities. Other NEHRPA agencies include the National Institute of Standards and Technology, National Science Foundation, and the U.S. Geological Survey.

Federal Guidelines for Dam Safety

In April 2004, Federal Emergency Management Agency published guidelines that represent the culmination of efforts, initiated by President Carter in April 1977, to review procedures and criteria used by federal agencies involved in the design, construction, operation, and regulation of dams and to prepare guidelines for management procedures to ensure dam safety. The guidelines are intended to outline federal agency management procedures that will continually stimulate technical methods in dam planning, design, construction, and operation for minimizing risk of failure. The objective of dam safety would be achieved as management and technical decisions during all project stages would give proper recognition to safety considerations. The strategy of these guidelines toward that end is to describe definite management practices to reinforce decision-maker awareness of safety needs. These guidelines apply to federal practices for dams with a direct federal interest and are not intended to supplant or otherwise conflict with State or local government responsibilities for safety of dams under their jurisdiction.

3.13.2.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Act (California Public Resources Code, Sections 2621–2630) was passed in 1972 to mitigate the hazard of surface faulting to structures designed for human occupancy. The main purpose of the law is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The law addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards. The Alquist-Priolo Act requires the State Geologist to establish regulatory zones, known as Alquist-Priolo Earthquake Fault Zones, around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning efforts. Before a project can be permitted in a designated Alquist-Priolo Earthquake Fault Zone, cities and counties must require a geologic investigation to demonstrate that proposed buildings would not be constructed across active faults.

Seismic Hazards Mapping Act

The Seismic Hazards Mapping Act of 1990 (California Public Resources Code, Sections 2690–2699.6) addresses earthquake hazards from non-surface fault rupture, including liquefaction and seismically induced landslides. The act established a mapping program for areas that have the potential for liquefaction, landslide, strong ground shaking, or other earthquake and geologic hazards. The act also specifies that the lead agency for a project may withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into plans to reduce hazards associated with seismicity and unstable soils.

National Pollutant Discharge Elimination System Permit

In California, the State Water Resources Control Board administers regulations promulgated by the U.S. Environmental Protection Agency (55 CFR Chapter 47990), requiring the permitting of stormwater-generated pollution under the National Pollutant Discharge Elimination System (NPDES). In turn, the State Water Resources Control Board's jurisdiction is administered through nine Regional Water Quality Control Boards. Under these federal regulations, an operator must obtain a General Construction Permit through the NPDES Stormwater Program for all construction activities with ground disturbance of 1 acre or more. The General Construction Permit requires the implementation of best management practices (BMPs) to reduce sedimentation into surface waters and to control erosion. One element of compliance with the NPDES permit is the preparation of a Stormwater Pollution Prevention Plan (SWPPP) that addresses control of water pollution, including sediment, in runoff during construction.

California Building Standards Code

The state regulations protecting structures from geo-seismic hazards are contained in the California Building Code (CBC) (24 CCR Part 2), which is updated on a triennial basis. These regulations apply to public and private buildings in the State. Until January 1, 2008, the CBC was based on the current Uniform Building Code and contained additions, amendments, and repeals specific to building conditions and structural requirements of the State of California. The 2019 CBC, effective January 1, 2020, is based on the current International Building Code and enhances the sections dealing with existing structures. Seismic-resistant construction design is required to meet more stringent technical standards than those set by previous versions of the CBC. The Merced County Department of Public Works, Division of Building and Safety, oversees and enforces federal, state, and county building codes through the issuance of permits; however, most of the Modified Project would be constructed on lands owned by the federal government where local codes would not apply.

Chapters 16 and 16A of the 2019 CBC include structural design requirements governing seismically resistant construction, including (but not limited to) factors and coefficients used to establish seismic site class and seismic occupancy category for the soil/rock at the building location and the proposed building design. Chapters 18 and 18A include (but are not limited to) the requirements for foundation and soil investigations (Sections 1803 and 1803A); excavation, grading, and fill (Sections 1804 and 1804A); damp-proofing and water-proofing (Sections 1805 and 1805A); allowable load-bearing values of soils (Sections 1806 and 1806A); the design of foundation walls, retaining walls, embedded posts and poles (Sections 1807 and 1807A), and foundations (Sections 1808 and 1808A); and design of shallow foundations (Sections 1809 and 1809A) and deep foundations (Sections 1810 and 1810A). Chapter 33 of the 2019 CBC includes (but is not limited to) requirements for safeguards at worksites to ensure stable excavations and cut or fill slopes (Section 3304).

Construction activities are subject to occupational safety standards for excavation and trenching, as specified in the California Safety and Health Administration regulations (Title 8 of the California Code of Regulations) and in Chapter 33 of the CBC. These regulations specify the measures to be used for excavation and trench work where workers could be exposed to unstable soil conditions.

California Department of Water Resources, Division of Safety and Dams

DWR's Division of Safety of Dams (DSOD) enforces dam safety requirements, assists with the evaluation of risks posed by existing and proposed dams, and implements inspection programs to ensure that dams are properly maintained and operated. DSOD engineers and engineering geologists review and approve plans and specifications for the design of dams and oversee construction to ensure compliance with the approved plans and specifications. Reviews include site geology, seismic setting, site investigations, construction material evaluation, dam stability, hydrology, hydraulics, and structural review of appurtenant structures. In addition, DSOD engineers inspect over 1,200 dams on a yearly schedule to ensure those dams are performing and being maintained in a safe manner.

California Health and Safety Code

Sections 17922 and 17951–17958.7 of the California Health and Safety Code require cities and counties to adopt and enforce the current edition of the CBC, including a grading section. Sections of Volume II of the CBC specifically apply to select geologic hazards.

Surface Mining and Reclamation Act

The Surface Mining and Reclamation Act of 1975 (Public Resources Code, Sections 2710-2796) provides a comprehensive surface mining and reclamation policy for the regulation of surface mining operations to assure that adverse environmental impacts are minimized and mined lands are reclaimed to a usable condition when mining operations are completed. The Surface Mining and Reclamation Act also encourages the production, conservation, and protection of California mineral resources. Public Resources Code 2207 provides annual reporting requirements for all mines in the state, under which the State Mining and Geology Board is also granted authority and obligations. The Surface Mining and Reclamation Act, Chapter 9, Division 2 of the Public Resources Code, requires the State Mining and Geology Board to adopt State policy for the reclamation of mined lands and the conservation of mineral resources. These policies are prepared in accordance with the Administrative Procedures Act (Government Code) and are in California Code of Regulations, Title 14, Division 2, Chapter 8, Subchapter 1.

Government Code Section 65302

This code mandates that general plan land use elements address the distribution of mineral resources and provisions for continued availability of those resources. The Governor's Office of Planning and Research has established guidelines to ensure that general plan contents meet the requirements of Government Code Section 65302.

San Luis Reservoir State Recreation Area Resource Management Plan/General Plan

The San Luis Reservoir State Recreation Area Resource Management Plan/General Plan (San Luis Reservoir SRA RMP/GP) was prepared to set forth goals and guidelines for management of the San Luis Reservoir State Recreation Area and adjacent lands (known as the Plan Area) for the next 25 years and was prepared in accordance with the Bureau of Reclamation's (Reclamation's) Resource Management Plan Guidebook, Planning for the Future (Reclamation 2003) and the California Department of Parks and Recreation's (CDPR's) California State Parks Planning

Handbook (CDPR 2010). The 27,000-acre Plan Area includes the water surfaces of San Luis Reservoir, O'Neill Forebay, and Los Banos Creek Reservoir, as well as adjacent recreation lands. CDPR, DWR, and the California Department of Fish and Wildlife manage the Plan Area lands, which are owned by Reclamation. The San Luis Reservoir SRA RMP/GP was developed through an agreement between Reclamation and CDPR to provide coordinated direction for recreation and resource management of the Plan Area lands, while continuing to serve the primary purpose of water storage, water distribution, and power generation. The San Luis Reservoir SRA RMP/GP sets forth Plan Area-wide management goals and guidelines that will be used to implement Plan Area use and future actions and to measure its success (Reclamation and CDPR 2013). The San Luis Reservoir SRA RMP/GP takes into account local and regional planning guidance including local general plans, water resources plans, and transportation plans, and directs that this local and regional guidance be considered in project decisions for the Plan Area.

3.13.2.3 Local

Merced County Multi-Jurisdictional Local Hazard Mitigation Plan

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) legally requires state, local, tribal, and territorial governments to develop and adopt Federal Emergency Management Agency–approved hazard mitigation plans as a condition of receiving certain types of non-emergency disaster assistance. The regulations, under Title 44, Chapter 1, Part 201 of the Code of Federal Regulations contain requirements and procedures to implement the hazard mitigation planning provisions of the Stafford Act. The purpose of the Merced County Multi-Jurisdictional Local Hazard Mitigation Plan is to identify hazards within Merced County, review and assess past disaster occurrences, estimate the probability of future occurrences, and set goals to mitigate potential risks to reduce or eliminate long-term risk to people and property from natural and human-made disasters.

Merced Vision 2030 General Plan

As required by state law, Merced County has adopted a general plan to guide land use decisions within the county. The general plan provides goals, policies, standards, and implementation programs to guide the physical development of a county. At a minimum, the general plan must address the topics of land use, transportation, housing, conservation, open space, noise, and safety. The Merced Vision 2030 General Plan (Merced County General Plan), adopted in 2013, has established the year 2030 as the plan's time horizon. The Health and Safety Element of the Merced County General Plan, in part, summarizes mitigation goals and specific policies related to seismic hazards, slope instability, and soil instability. Moreover, the Natural Resources Element contains goals and policies related to soil and mineral resources. The following goal and policies would apply to the Modified Project (Merced County 2013b):

Health and Safety Element

Goal HS-1: Minimize the loss of life, injury, and property damage of County residents due to seismic and geologic hazards.

- **Policy HS-1.1: Structure Location and Compliance**. Require that all new habitable structures be located and designed in compliance with the Alquist-Priolo Special Studies Zone Act and related State earthquake legislation.
- **Policy HS-1.2: Financial Assistance for Seismic Upgrades**. Support efforts to obtain financial assistance from Federal and State agencies in order to implement corrective seismic safety measures required for existing County buildings and structures.

- **Policy HS-1.3: Dam Inundation Areas**. Require all new structures located within dam inundation areas to conform to standards of dam safety as required by the State Division of Safety of Dams.
- **Policy HS-1.4: Ensure Earthquake Resistant Design**. Require earthquake-resistant design for proposed critical structures such as hospitals, fire stations, emergency communication centers, private schools, high occupancy buildings, bridges and freeway overpasses, and dams that are subject to County permitting requirements.
- **Policy HS-1.5: Public Education.** Encourage educational programs to inform the public of earthquake dangers in Merced County.
- **Policy HS-1.6: Landslide Areas**. Prohibit habitable structures on areas of unconsolidated landslide debris or in areas vulnerable to landslides.
- **Policy HS-1.7: Hillside Development**. Discourage construction and grading on slopes in excess of 30%.
- **Policy HS-1.8: Grading Standards**. Require that the provisions of the International Building Code be used to regulate projects subject to hazards from slope instability.
- **Policy HS-1.9: Unstable Soils**. Require and enforce all standards contained in the International Building Code related to construction on unstable soils.

Natural Resources Element

Goal NR-3: Facilitate orderly development and extraction of mineral resources while preserving open space, natural resources, and soil resources and avoiding or mitigating significant adverse impacts.

- **Policy NR-3.1: Soil Protection.** Protect soil resources from erosion, contamination, and other effects that substantially reduce their value or lead to the creation of hazards.
- **Policy NR-3.2: Soil Erosion and Contamination.** Require minimal disturbance of vegetation during construction to improve soil stability, reduce erosion, and improve stormwater quality.
- **Policy NR-3.4: New Development Compatibility.** Ensure that new development is compatible with existing and potential surface mining areas and operations as identified on the Mineral Resource Zone Maps prepared by the State Division of Mines and Geology and other mineral resource areas identified by the County. The County shall:
    a. Require development applicants near identified mineral resources to prepare a statement that specifies why the County should permit the proposed land use and describe how the benefits of the proposed use would clearly outweigh the impacts that may limit the potential to extract mineral resources in that area.
    b. Require new incompatible land uses adjacent to existing mining operations to provide a buffer between the development and adjacent mining operations adequate to mitigate significant impacts to mineral land uses. The buffer distance shall be based on an evaluation of noise, aesthetics, drainage, operating conditions, biological resources, topography, lighting, traffic, operating hours, and air quality.
    c. Require written notification to be sent to mining operators and subject landowners of land use entitlement applications for potentially incompatible land uses in areas where mining operations are currently taking place.
- **Policy NR-3.5: Mineral Resource Protection.** Require areas identified with mineral deposits on either the State Mine Land Classification Maps provided by the State Mining and Geology Board's Classification Report, or site-specific information, remain protected for possible future mineral extraction. Impose conditions upon new incompatible land uses in areas surrounding identified mineral deposits for the purpose of mitigating significant land-use conflicts prior to approving a use that would otherwise be incompatible with mineral extraction. The identified mineral deposit may be determined by the classification maps, Classification Report, separate County maps, or on a site-specific basis.

- **Policy NR-3.6: Buffers between Mining Operations and Adjacent Uses**. Require operators of new mines to provide buffers or physical barriers between the mining operation and any existing nearby incompatible land uses when a significant impact is identified during the development review process.
- **Policy NR-3.8: Habitat Restoration and Buffer Incentives.** Support and encourage property owners and surface mining operators to pursue one or more of the following incentives:
  a. State and Federal habitat restoration funding for restoring wildlife habitat;
  b. Conservation easements following reclamation for restoring wildlife habitat; and
  c. Other local, State, and Federal incentives.
- **Policy NR-3.9: Riparian and Critical Habitat Protection**. Protect or mitigate, in compliance with local, State, and Federal requirements, areas of riparian vegetation along rivers, streams, and other habitats that support threatened, endangered, or otherwise sensitive species. This shall include:
  a. Requiring mining operators that propose mining operations that will have a significant adverse impact on these resources to mitigate to the fullest extent that the California Environmental Quality Act (CEQA) requires for such impacts and obtain the necessary State and Federal permits prior to operation.
  b. Encouraging mining operators that impact natural resources to propose an end-use that will result in minimal loss of resources.
  c. Referring all surface mining applications to the appropriate local, State, and Federal agencies to coordinate project design, mitigation, and reclamation efforts.
- **Policy NR-3.11: Concurrent Reclamation.** Require reclamation of mining sites concurrent with extraction activities rather than after extraction has been completed.
- **Policy NR-3.12: Sand and Gravel Extraction Control.** Ensure that strict control is maintained on sand and gravel extractions in streambed channels and within areas designated as having sensitive habitat and open space resources.

3.13.3 Thresholds of Significance

The following significance criteria from the 2019 EIS/EIR are used for the purposes of analysis in this SEIR. These criteria, which have not changed from the 2019 EIS/EIR, are identified in Chapter 25, Geology, Seismicity, and Soils, of the 2019 EIS/EIR. A significant impact related to geology and soils would occur if the Modified Project would:

1. Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
   a. Rupture of a known earthquake fault, based on substantial evidence of a known fault.
   b. Strong seismic ground shaking.
   c. Seismic-related ground failure, including liquefaction.
   d. Landslides.
2. Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Modified Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
3. Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property.

4. Result in substantial soil erosion or the loss of topsoil.
5. Result in the loss of availability of a known mineral resource that would be of value to the region and residents of the State.
6. Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.

3.13.4 Impacts Analysis

Threshold 1

Would the Modified Project expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:

a. Rupture of a known earthquake fault, based on substantial evidence of a known fault?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

The Modified Project would result in the construction of a new permanent campground on the northwestern shoreline of O'Neill Forebay and include improvements to the existing San Luis Creek Day Use Area along the western shoreline (Figure 2-4A). None of the additional impact areas, including the proposed campground and San Luis Creek Day Use Area, is located within an Alquist-Priolo Earthquake Fault Zone, or is underlain by a known earthquake fault. The closest Alquist-Priolo Fault Zone is associated with the Cottonwood Arm section of the Ortigalita Fault Zone, which is located approximately 2.8 miles southwest of the proposed campground and 2.3 miles southwest of the existing day use area (Figure 3.13-3). Furthermore, the construction, improvement, and operation of the new campground and day use area would not directly cause or exacerbate existing fault rupture risks. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, based on substantial evidence of a known fault. Therefore, **no impacts** would occur.

Changes in Borrow Area Location

The Modified Project has identified two additional borrow areas, Borrow Area 12 and Borrow Area 14, in addition to Borrow Area 6 and the Basalt Hill Borrow Area that were identified as part of the Approved Project in the 2019 EIS/EIR. Borrow Areas 12 and 14 are within the overall construction footprint identified by the 2019 EIS/EIR, but were identified in that document and analyzed as anticipated contractor staging areas. Near the Basalt Hill Borrow Area, the Modified Project also includes addition of a new work area proposed for stockpiling extracted materials prior to transporting the materials to the dam construction zone. The Basalt Hill Borrow Area, shown on Figure 3.13-2, was used to extract materials for the original dam construction. An existing access road from Basalt Road would be widened and improved for hauling uses as part of the Modified Project. As discussed in Section 3.13.1, no additional impact areas are located within an Alquist-Priolo Fault Zone or underlain by a known fault. The closest Alquist-Priolo Fault Zone to these additional impact areas is associated with the Cottonwood Arm section of the Ortigalita Fault Zone, which is located approximately 2.5 miles northwest of Borrow Areas 12 and 14, at the closest

point (Figure 3.13-3).[4] Furthermore, borrow area extraction, grading, and restoration would not directly cause or exacerbate existing fault rupture risks. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, based on substantial evidence of a known fault. Therefore, **no impacts** would occur.

Minor Additions to Contractor Work Area

The additional impact areas include some minor expansion of contractor work areas that were not part of the original study area addressed in the 2019 EIS/EIR. These areas include several staging/soil stockpiling areas downstream of B.F. Sisk Dam, which would later be covered by the stability berms and expanded dam embankment, as well as another small area of less than one acre immediately west of the dam's right abutment, where a haul road would be widened (Figure 2-4A, Figure 2-4B, and Figure 3.13-2). However, as discussed above, the additional impact areas would not be located within an Alquist-Priolo Fault Zone and are not underlain by a known fault. The closest Alquist-Priolo Fault Zone to the additional impact areas is associated with the Cottonwood Arm section of the Ortigalita Fault Zone, which is located approximately 1.3 miles west of these contractor work areas, at the closest point (Figure 3.13-3). Furthermore, additions to the contractor work areas would not directly cause or exacerbate existing fault rupture risks. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, based on substantial evidence of a known fault. Therefore, **no impacts** would occur.

Additional Construction Assumptions

Additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to regional faulting. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving rupture of a known earthquake fault, based on substantial evidence of a known fault. Therefore, **no impacts** would occur.

Cumulative Impacts

Potential impacts related to rupture of a known earthquake fault at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Cumulative projects would be required to prepare and submit a site-specific geotechnical report for review and approval prior to the issuance of grading or building permits. Additionally, as needed, projects would incorporate individual mitigation or geotechnical requirements for site-specific geologic hazards, including fault rupture, on each individual cumulative project site. Although the B.F. Sisk Dam Raise and Reservoir Expansion Project (reservoir expansion project) would generally be located in the same location as the Modified Project, the structural component of this cumulative project, the dam embankment, is not underlain by a Holocene-active or pre-Holocene fault. The closest Alquist-Priolo Fault Zone to the dam embankment is associated with the Cottonwood Arm section of the Ortigalita Fault Zone, which is located approximately 1.0 mile southwest of the dam, at the closest point (Figure 3.13-3). Additional stabilization measures and raising the crest of the dam, as proposed for this cumulative project, would result in beneficial impacts by reinforcing the dam to better withstand effects of seismicity. Therefore, impacts associated with rupture of a known earthquake fault are not cumulatively considerable and **no impacts** would occur.

[4] The Alquist-Priolo Fault Zone associated with this fault only encompasses the portion of the fault located north of San Luis Reservoir.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in no impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

b. Strong seismic ground shaking?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

The Modified Project site, including the proposed campground and day use area improvements, is in a seismically active region of California. Movement along major faults in proximity of the Modified Project site (e.g., the San Andreas, Ortigalita, O'Neill, and Calaveras Faults) can produce moderate to large earthquakes that could affect the proposed campground and improvements. However, proposed structures at the campground and day use area would be constructed in accordance with the CBC, which provides procedures for earthquake-resistant structural design. The CBC considers on-site soil conditions, occupancy, and the configuration of the structure, including the structural system and height. The CBC would require completion of a site-specific geotechnical investigation at the campground and day use area to ensure that recreational and structures (e.g., restrooms, shower buildings, campfire center) would be designed and constructed to withstand maximum anticipated ground accelerations associated with a large earthquake. Although substantial damage to structures may be unavoidable during large earthquakes, the proposed structures would be designed to resist structural failure and thereby provide reasonable protection from serious injury, catastrophic property damage, and loss of life.

As discussed in Section 3.13.2, Relevant Plans, Policies, and Ordinances, Chapters 18 and 18A of the CBC include (but are not limited to) the requirements for foundation and soil investigations (Sections 1803 and 1803A); excavation, grading, and fill (Sections 1804 and 1804A); damp-proofing and water-proofing (Sections 1805 and 1805A); allowable load-bearing values of soils (Sections 1806 and 1806A); the design of foundation walls, retaining walls, embedded posts and poles (Sections 1807 and 1807A), and foundations (Sections 1808 and 1808A); and design of shallow foundations (Sections 1809 and 1809A) and deep foundations (Sections 1810 and 1810A).

In addition to being constructed in accordance with state building codes, construction of the campground and day use area would not directly or indirectly cause substantial adverse effects involving strong seismic ground shaking. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking. Therefore, impacts would be **less than significant**.

With respect to campground and day use area operations, the Modified Project would be designed to reduce the risks associated with potential seismically induced dam failure and associated flooding of these additional impact areas. As described in Section 2.2, Existing B.F. Sisk Dam Features and Stability Concerns, of this SEIR, studies of the seismic safety of dam completed by Reclamation and DWR determined that less-dense soils under the dam and in the dam abutments could undergo liquefaction during a seismic event and result in significant deformation (crest settlement) of the dam in the sections built on the alluvium and clayey slopewash. The probabilistic risk

analysis determined that failure of the dam is very unlikely, but that consequences of a dam failure would be severe and therefore do not meet Reclamation's Public Protection Guidelines and warrant corrective action. Corrective action studies were carried out by Reclamation with participation by DWR.

These corrective action studies indicated that deformation potential would be addressed by removing the alluvium and clayey slopewash, constructing downstream stability berms keyed into the underlying bedrock, and raising the dam crest 12 feet to increase the reservoir's freeboard, or the distance between the water surface and the dam crest. Raising the dam would be accomplished by placing additional material on the downstream face of the embankment, which would also serve to strengthen the embankment. These measures to alleviate risk associated with a seismic event would be implemented as part of the Approved Project evaluated in the 2019 EIS/EIR, thus reducing the potential for seismically induced dam failure and flooding of the proposed campground and day use area.

Changes in Borrow Area Location

As discussed for Threshold 1a, the Modified Project may include soil and bedrock extraction from Borrow Areas 12 and 14, as well as use of a new soil stockpiling area near the Basalt Hill Borrow Area. Materials extraction at Borrow Areas 12 and 14 is intended to preserve the existing topographic contours of the borrow areas to the greatest extent practicable, with the elevation of the existing hills and ridges being lowered up to 25 feet from their current elevation. If Borrow Area 14 is used, excavation would be minimized at the lower elevations and defined drainage areas between the hills. Up to 7 million cubic yards of material would potentially be removed from these borrow areas. As part of the Modified Project, a remediation plan would be prepared and implemented for these borrow areas, including measures to revegetate and perform final grading to achieve a naturalized appearance and topography consistent with goals and guidelines of the San Luis Reservoir RMP/GP. Grading would be completed in accordance with the CBC and site-specific geotechnical report recommendations, ensuring that on-site slopes would be stabilized and not over-steepened, thus reducing the potential for seismically induced slope failure. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking. Therefore, impacts would be **less than significant**.

Minor Additions to Contractor Work Area

As discussed under Threshold 1a, additional impact areas include some minor expansion of contractor work areas that were not part of the original study area addressed in the 2019 EIS/EIR. No structures would be built in these additional impact areas and no slopes would be constructed that might be subject to seismically induced ground failure. Moreover, no portion of the Modified Project would increase or exacerbate the risk of seismically induced ground-shaking. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death, including strong seismic ground shaking. Therefore, impacts would be **less than significant**.

Additional Construction Assumptions

As discussed in Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to regional seismicity. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking. Therefore, **no impacts** would occur.

Cumulative Impacts

Potential impacts related to seismically induced ground shaking at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Cumulative projects would be required to prepare and submit a site-specific geotechnical report for review and approval prior to the issuance of grading or building permits. Additionally, as needed, projects would incorporate individual mitigation or geotechnical requirements for site-specific geologic hazards, including seismically induced ground shaking, on each individual cumulative project site. Although the reservoir expansion project would generally be located in the same location as the Modified Project, additional stabilization measures and raising the crest of the dam, as proposed for this cumulative project, would result in beneficial impacts with respect to seismicity. Therefore, impacts associated with strong seismically induced ground shaking are not cumulatively considerable and impacts would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

c. Seismic-related ground failure, including liquefaction?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

Hazards associated with soil liquefaction and seismic-related ground failure include temporary loss of soil bearing capacity, lateral spreading, differential compaction, and slope instability. As discussed in Section 3.13.1, groundwater levels are typically high near-surface water bodies, such as San Luis Reservoir and O'Neill Forebay. As such, given the potential high water table, areas of unconsolidated Holocene alluvium, and proximity to Holocene-active faults (e.g., Ortigalita, O'Neill, and San Joaquin Faults), the additional impact areas, including portions of the proposed campground and day use area improvements underlain by alluvium (Figure 3.13-2), may be susceptible to liquefaction and seismic ground failure.

However, CBC standards would require the completion of a site-specific geotechnical investigation report for any proposed structures at the new campground and San Luis Creek Day Use Area. The geotechnical investigations would include site-specific design and construction recommendations to ensure that new structures are not adversely affected by seismically induced loss of soil bearing capacity, lateral spreading, differential compaction, and seismically induced slope instability. Design and construction would be completed in accordance with the CBC. Incorporation of CBC requirements, and standard geotechnical recommendations would minimize the potential for seismically related ground failure, including liquefaction, to occur.

Construction of the campground and improvements of the day use area would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction. Therefore, impacts would be **less than significant**.

With respect to campground and day use area operations, the Modified Project would be designed to reduce the risks associated with potential seismically induced dam failure, including failure associated with liquefaction, and associated flooding of the proposed campground and existing day use area. Impacts would be similar to those described above for Threshold b regarding strong seismic ground shaking.

Changes in Borrow Area Location

Loose unconsolidated Holocene alluvium within the canyon bottoms of Borrow Area 14 and the additional staging and stockpiling area near the Basalt Hill Borrow Area may be susceptible to liquefaction (Figure 3.13-2). However, no structures would be built within these areas. Moreover, neither extraction, grading, and restoration of the borrow areas nor the use of the new staging area would increase or exacerbate the risk of seismically induced ground failure. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction. Therefore, impacts would be **less than significant**.

Minor Additions to Contractor Work Area

The additional staging and stockpiling areas immediately downstream of the dam embankment are underlain by Panoche Formation bedrock and are therefore not susceptible to liquefaction (Figure 3.13-2). Moreover, no portion of the Modified Project would increase or exacerbate the risk of seismic-related ground failure, including liquefaction. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving seismic-related ground failure, including liquefaction. Therefore, impacts would be **less than significant**.

Additional Construction Assumptions

As discussed for Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to regional seismicity. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving strong seismic ground shaking. Therefore, **no impacts** would occur.

Cumulative Impacts

Potential impacts related to seismically related ground failure, including liquefaction, at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Cumulative projects would be required to prepare and submit a site-specific geotechnical report for review and approval prior to the issuance of grading or building permits. Additionally, as needed, projects would incorporate individual mitigation or geotechnical requirements for site-specific geologic hazards, including seismically related ground failure, including liquefaction, on each individual cumulative project site. Although the reservoir expansion project would generally be located in the same location as the Modified Project, additional stabilization measures and raising the crest of the dam, as proposed for this cumulative project, would result in beneficial impacts with respect to seismicity. Therefore, impacts associated with seismically related ground failure, including liquefaction, are not cumulatively considerable and impacts would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

d. Landslides?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

Hillside areas of the proposed campground and existing day use areas are generally gentle to moderately sloped, with localized areas of steep slopes. No landslides have been mapped in these areas (Figure 3.13-2). Slope instability during construction typically occurs because of the over-steepening of temporary slopes or excavations into the toe of unstable slopes. Excavation of temporary slopes would be completed in accordance with the California Division of Occupational Safety and Health standards, and construction of permanent slopes would be completed in accordance with CBC standards, thus minimizing the potential for construction-induced landslides to occur. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death resulting from landslides. Therefore, impacts would be **less than significant.**

With respect to campground and day use area operations, the Modified Project would be designed to reduce the risks associated with potential seismically induced dam failure, including seismically induced landslides, and associated flooding of the proposed campground and existing day use area. Impacts would be similar to those described above for Threshold b regarding strong seismic ground shaking.

Changes in Borrow Area Location

Materials extraction at Borrow Areas 12 and 14 is intended to preserve the existing topographic contours of the borrow areas to the greatest extent practicable, with the elevation of the existing hills and ridges being lowered up to 25 feet from their current elevation. If Borrow Area 14 is used, excavation would be minimized at the lower elevations and defined drainage areas between the hills. Up to 7 million cubic yards of material would be removed from these borrow areas if the materials testing determines that they contain suitable material for construction.

The slope gradients of Borrow Areas 12 and 14 are generally gentle to moderate, with localized areas of moderately steep hillsides. No landslides have been mapped in these areas (Figure 3.13-2). Improper material extraction techniques during removal of up to 25 vertical feet of these hills could result in oversteepened slopes, unstable soil conditions, and landsliding. However, excavations of temporary slopes would be completed in accordance with California Division of Occupational Safety and Health standards, and construction of permanent slopes would be completed in accordance with CBC standards, thus minimizing the potential for excavation-induced landslides to occur. Excavations would also be conducted in accordance with site-specific geotechnical recommendations. Moreover, once material extraction has ceased, the borrow areas would be graded and restored back to natural landform, stabilizing on-site soils, and reducing the potential for slope instability. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death resulting from landslides. Therefore, impacts would be **less than significant**.

Minor Additions to Contractor Work Area

The topography of the additional staging and stockpiling areas immediately downstream of the dam embankment is gently sloping and no landslides have been mapped in these areas (Figure 3.13-2). Minimal grading, if any, would be required for creation of the staging and stockpiling areas. As a result, slope instability would not occur. As such, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides. Therefore, impacts would be **less than significant**.

Additional Construction Assumptions

As discussed for Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to landslides. As a result, this element of the Modified Project would not expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving landslides. Therefore, **no impacts** would occur.

Cumulative Impacts

Potential impacts related to landslides at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Cumulative projects would be required to prepare and submit a site-specific geotechnical report for review and approval prior to the issuance of grading or building permits. Additionally, as needed, projects would incorporate individual mitigation or geotechnical requirements for site-specific geologic hazards, including landslides, on each individual cumulative project site. Although the reservoir expansion project would generally be located in the same location as the Modified Project, additional stabilization measures, as proposed for this cumulative project, would result in beneficial impacts with respect to landslides, including seismically induced landslides. Therefore, impacts associated with landslides are not cumulatively considerable and impacts would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

Threshold 2

Would the Modified Project be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Modified Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

As discussed for Threshold 1c, although alluvial areas of the proposed campground and existing day use area may be prone to liquefaction and associated lateral spreading, any new structures would be built in accordance with the CBC, such that adverse impacts would not occur. With implementation of the Modified Project, campground and day use area operations would be less susceptible to flooding as a result of seismically induced dam failure, resulting in beneficial impacts. Hillside portions of the proposed campground and existing day use area are underlain by Panoche Formation bedrock, which would not be prone to soil collapse. However, sandy alluvial soils may be prone to soil collapse. Construction on potentially collapsible soils in these alluvial areas would similarly be mitigated through compliance with the CBC, including allowable load-bearing values of soils (Sections 1806 and 1806A); and the design of embedded posts/poles (Sections 1807 and 1807A) and foundations (Sections 1808 and 1808A). These measures are designed to assure safe construction requirements appropriate to site conditions. Excavation of cut slopes in hillside areas would be constructed in accordance with the CBC, such that on- or off-site landslides would not occur. As discussed in Section 3.13.1, the Modified Project site is not located within a known subsidence area. Therefore, this element of the Modified Project would not result in additional impact areas becoming unstable and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. Impacts would be **less than significant**.

Changes in Borrow Area Locations

Borrow Areas 12 and 14 are underlain by Panoche Formation bedrock and alluvium (Figure 3.13-2). Bedrock areas would not be prone to liquefaction or soil collapse. Although alluvial canyon areas may be prone to liquefaction, lateral spreading, and soil collapse, no structures would be built in these additional impact areas; therefore, no impacts would occur. As discussed for Threshold 1d, improper material extraction techniques could result in oversteepened slopes, unstable soil conditions, and landsliding. However, excavations of temporary slopes would be completed in accordance with California Division of Occupational Safety and Health and CBC standards, thus minimizing the potential for excavation-induced landslides to occur. Moreover, once material extraction has ceased, the borrow areas would be graded and restored back to natural landform, stabilizing on-site soils and reducing the potential for slope instability. The Modified Project area is not in an area of known subsidence and borrow area excavations would not induce subsidence. Therefore, this element of the Modified Project would not result in additional impact areas becoming unstable and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. Impacts would be **less than significant.**

Minor Additions to Contractor Work Area

The topography of the additional staging and stockpiling areas immediately downstream of the dam embankment is gently sloping and no landslides have been mapped in these areas (Figure 3.13-2). Minimal grading, if any, would be required for creation of the staging and stockpiling areas. As a result, slope instability would not occur. These additional impact areas are primarily underlain by Panoche Formation bedrock, which would not be prone to liquefaction or soil collapse. The Modified Project area is not in an area of known subsidence and creation of additional contractor work areas would not induce subsidence. Therefore, this element of the Modified Project would not result in additional impact areas becoming unstable and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. Impacts would be **less than significant.**

Additional Construction Assumptions

As discussed for Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to landslides, liquefaction, lateral spreading, or collapse. As discussed, dewatering of stability berm excavations would not induce subsidence. Therefore, this element of the Modified Project would not result in additional impact areas becoming unstable and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse. **No impacts** would occur.

Cumulative Impacts

As described for Threshold 1, potential impacts related to seismically induced ground failure, landslides, and collapse at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Therefore, impacts associated with these geologic hazards are not cumulatively considerable and impacts would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

Threshold 3

Would the Modified Project be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

Expansive soils are clay-rich soils that shrink when dry and swell when wet. This change in volume can exert substantial pressure on foundations, resulting in structural distress and/or damage. As discussed in Section 3.13.1, some soils underlying the proposed campground and San Luis Creek Day Use area contain clay, and thus may be susceptible to soil expansion. Grading and construction in expansive soils would be mitigated through compliance with the CBC. Typical mitigation measures described in Chapter 18 of the CBC to alleviate expansive soils include the following:

- Excavation of the upper few feet of expansive soils and replacement with sandy, nonexpansive soil;
- Installation of foundations designed to resist forces exerted by expansive soils; and
- Stabilization of the soils by chemical, dewatering, pre-saturation, or equivalent techniques.

In addition, construction and operation of the campground and day use area would not directly or indirectly cause substantial adverse effects related to expansive soils. As such, this element of the Modified Project would not create substantial direct or indirect risks to life and property related to expansive soils and impacts would be **less than significant**.

Changes in Borrow Area Location

Expansive soils may be present within Borrow Areas 12 and 14 and may underlie portions of the newly proposed staging area near the Basalt Hill Borrow Area. However, no structures that might be affected by expansive soils are proposed to be developed within these additional impact areas. As such, this element of the Modified Project would not create substantial direct or indirect risks to life and property related to expansive soils and impacts would be **less than significant**.

Minor Additions to Contractor Work Area

As discussed for the proposed campground and day use area improvements, the additional soil and stockpiling areas are underlain by soils containing clay that may be susceptible to expansion. However, no structures that might be affected by expansive soils are proposed to be developed within these additional impact areas. As such, this element of the Modified Project would not create substantial direct or indirect risks to life and property related to expansive soils and impacts would be **less than significant**.

Additional Construction Assumptions

As discussed for Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to expansive soils. Therefore, this element of the Modified Project would not create substantial direct or indirect risks to life and property related to expansive soils. **No impacts** would occur.

Cumulative Impacts

Potential impacts related to expansive soils at cumulative project sites would be reduced on a site-by-site basis by modern construction methods and compliance with CBC regulatory requirements that ensure building safety. Cumulative projects would be required to prepare and submit a site-specific geotechnical report for review and approval prior to the issuance of grading or building permits. Additionally, as needed, projects would incorporate individual mitigation or geotechnical requirements for site-specific geologic hazards, including expansive soils, on each individual cumulative project site. Therefore, impacts associated with expansive soils are not cumulatively considerable and impacts would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

Threshold 4

Would the Modified Project result in substantial soil erosion or the loss of topsoil?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Campground Construction and Day Use Area Improvements

Construction activities associated with the development of the proposed campground and redevelopment of the day use area, including grading and open trenching for utility installation, would produce exposed soils that could be susceptible to erosion as a result of rain, windy conditions, and/or construction vehicles traveling over the exposed soils. However, state and federal NPDES requirements include the preparation and implementation of a SWPPP for projects with cumulative ground disturbance more than 1 acre. In compliance with Construction General Permit requirements, the SWPPP would establish erosion and sediment control BMPs for construction activities. Typical examples of erosion-related construction BMPs include the following:

- Silt fences and/or fiber rolls installed around the perimeter of work areas and/or the project construction site
- Stockpile containment and exposed soil stabilization structures (e.g., Visqueen plastic sheeting, fiber rolls, gravel bags and/or hydroseed)
- Runoff control devices (e.g., fiber rolls, gravel bag barriers) used during construction phases conducted during the rainy season
- Wind erosion (dust) controls, primarily consisting of spraying water on exposed dry soils with a water truck
- Tracking controls at the site entrance, including regular street sweeping and tire washes for equipment

These measures would control and reduce erosion and loss of topsoil to the maximum extent practical. Once construction is complete, exposed soils would be paved over and/or revegetated, thus minimizing long-term erosional impacts. Therefore, this element of the Modified Project would not result in substantial soil erosion or loss of topsoil and impacts would be **less than significant**.

Changes in Borrow Area Location

Implementation of the Modified Project would involve the extraction and stockpile of soils from Borrow Area 12 and 14 that could be susceptible to erosion due to rain, windy conditions, and/or construction vehicles traveling over the exposed soils. However, DWR or their construction contractor would be required to prepare and implement a SWPPP, establishing erosion and sediment control BMPs near the borrow areas and staging site. BMPs would, in part, include covering exposed soil stockpiles during rain events, lining the perimeter of construction areas with sediment barriers, and installation of runoff control devices. Moreover, once extraction activities have ceased, Borrow Areas 12 and 14 would be graded and restored to natural landform, stabilizing on-site soils, and reducing the potential for soil erosion to occur. As such, this element of the Modified Project would not result in substantial soil erosion or loss of topsoil and impacts would be **less than significant**.

Minor Additions to Contractor Work Area

Clearing and grubbing for proposed staging/stockpiling areas, as well as temporary stockpiling of soils in these additional impact areas, could expose previously stabilized soils to erosion due to rain, windy conditions, and/or construction vehicles traveling over the exposed soils. However, DWR or their construction contractor would prepare and implement a SWPPP that would include erosion control measures, such as covering exposed soil stockpiles during rain events, lining the perimeter of construction areas with sediment barriers, and installation of runoff control devices. These measures would control and reduce erosion and loss of topsoil to the maximum extent practical. Once construction is complete, exposed soils would be revegetated, thus minimizing long-term erosion. Therefore, this element of the Modified Project would not result in substantial soil erosion or loss of topsoil and impacts would be **less than significant**.

Additional Construction Assumptions

As discussed for Threshold 1a, additional construction assumptions include changes to the construction schedule, equipment and personnel specifications, and dewatering specifications for proposed excavations at the base of the dam. These Modified Project components would have no relevance to soil erosion. Therefore, this element of the Modified Project would not result in substantial soil erosion or loss of topsoil and **no impacts** would occur.

Cumulative Impacts

Potential soil erosion from each cumulative project site could combine to cause potentially significant cumulative water quality impacts due to sedimentation of downstream water bodies. The geographic context for the analysis of cumulative erosion related impacts would be the San Joaquin River watershed. Cumulative development and redevelopment within the watershed would potentially result in short-term erosion related impacts during construction and long-term erosion related to denuded soil, improper drainage, and lack of erosion control features at each cumulative project site. However, short-term and long-term erosion control BMPs would be employed at each site consistent with NPDES stormwater quality regulations, including the Construction General Permit and local Municipal Separate Storm Sewer System permits, such that impacts would not be cumulatively considerable. (See Section 3.1, Water Quality and Groundwater, for additional analysis.) As a result, cumulative impacts related to soil erosion and loss of topsoil would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

Threshold 5

Would the Modified Project result in the loss of availability of a known mineral resource that would be of value to the region and residents of the State?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Impacts for all Project Components

According to mapping efforts by the CGS, CalGEM, and California Department of Conservation, Office of Mine Reclamation, no active or historic mines or oil wells are present within the Modified Project site. The closest oil well is an abandoned dry hole located along the eastern edge of O'Neill Forebay. Moreover, two active, two reclaimed, and one idle mine are present to the south and southeast of the Modified Project site (Table 3.13-2, Nearby Mine Sites in Merced County). On-site activities associated with the additional impact areas includes the extraction of materials from Borrow Areas 12 and 14 for construction activities at B.F. Sisk Dam. However, there is no known demand for these materials besides the Modified Project. As a result, this element of the Modified Project would not result in the loss of availability of known mineral resources that would be of value to the region and the residents of the State. Therefore, impacts would be **less than significant**.

Cumulative Impacts

The geographic context for the analysis of cumulative mineral resources related impacts would include the counties of Alameda, San Joaquin, Stanislaus, Merced, and portions of Fresno, including both valley and foothill areas. Although the majority of oil and gas production in the San Joaquin Valley occurs in the southern portion of the valley, near Bakersfield, oil and gas exploration has occurred in the northern San Joaquin Valley, as evidence by an abandoned well immediately east of O'Neill Forebay. Future oil and gas exploration would not be precluded in the vicinity of cumulative project sites and/or corridors as modern directional drilling techniques would allow access to oil reserves from remote locations.

Gravel quarries are located throughout the valley areas of the northern San Joaquin Valley, primarily in river alluvial areas, and rock and gravel mines and quarries are located throughout the foothills of the northern San Joaquin Valley. In addition, known occurrences of ultramafic rock outcrops are present in the western part of Merced County. Ultramafic rocks can contain commercially viable quantities of chrysotile asbestos and tremolite-actinolite asbestos. The San Luis Transmission Project would not preclude mineral resource development, as transmission lines typically have little impact to mining operations due to the spacing between transmission structures, which is large enough to accommodate access to mineral resource deposits. Should open pit mining be planned in the vicinity of transmission lines, structures can remain on islands, or the mining interest can have the transmission line locally re-routed. The San Luis Solar Project could impede quarrying for a period of 30 years; however, the land would be available to mining following the 30-year lease period. The San Luis Reservoir Low Point Improvement Project began in 2019 and includes designated quarry locations that have been subject to CEQA review. The reservoir expansion project would use quarried material from the Basalt Hill Borrow Area, which is located on federally owned land. Other than the Approved Project and Modified Project, there is no known demand for these quarries. Similarly, extraction of borrow material from the Basalt Hill Borrow Area, Borrow Area 12, and Borrow Area 14 for the Modified Project would result in extraction of material from borrow areas with no known additional demand. As a result, the Modified Project, in combination with the cumulative projects, would not result in the permanent loss of availability of a known mineral resource that would be of future value to the region and the residents of the state and use of the materials extracted from the quarry/borrow areas would be used for the purposes of dam improvement and reinforcement for the public benefit purposes of water storage and supply domestic and agricultural purposes. Furthermore, access to the quarries would remain following construction of these projects and remaining materials could be extracted for future projects requiring similar materials. The contribution of the Modified Project is less than cumulatively considerable and the cumulative impact is **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

Threshold 6

Would the Modified Project result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan?

2019 EIS/EIR Impact Determination	Modified Project Impact Determination	New Significant Increase in Impact Severity?
Less than Significant	Less than Significant	No

Impacts for all Project Components

As discussed in Section 3.13.1, no aggregate mines, gold mines, or oil/gas wells are in the vicinity of San Luis Reservoir or O'Neill Forebay. As a result, the Modified Project would not interfere with nearby mines or wells. The Modified Project would entail using materials from Borrow Areas 12 and 14 for the construction activities at B.F. Sisk Dam. However, there is no known demand for these materials outside of the Modified Project area. Moreover, no general plan, specific plan, or land use plan has identified the borrow areas as a locally important mineral resource. As a result, implementation of the Modified Project would not result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plans. Therefore, impacts would be **less than significant**.

Cumulative Impacts

The primary mineral resources of Merced County are sand and gravel mining operations, with significant aggregate deposits concentrated along the San Joaquin River and its tributaries, including the Merced River, the Modesto Formation, and the Los Banos, San Luis Ranch, Patterson, and Dos Palos Alluviums. Approximately 38 square miles, or 24,320 acres of aggregate resource areas have been identified by the California Division of Mines and Geology in 10 aggregate resource areas within Merced County. These 10 resource areas contain an estimate 1.18 billion tons of concrete resources overall. The Division of Mines and Geology estimates that 144 million tons of aggregate would be necessary to satisfy projected demand for construction aggregate in the county through 2049, which is well beyond the 2030 horizon contemplated by the Merced County General Plan (Merced County 2013b). As a result, the available supply of aggregate in Merced County would substantially exceed cumulative project demand. The Modified Project, in combination with the cumulative projects, would not result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plans. The contribution of the Modified Project is less than cumulatively considerable and the cumulative impact would be **less than significant**.

Comparison to 2019 EIS/EIR

The additional project components analyzed above would result in less-than-significant impacts and therefore impacts of the Modified Project would not result in a significant increase in the severity of impacts as determined in the 2019 EIS/EIR. Impacts of the Modified Project would remain less than significant.

3.13.5 Mitigation Measures

No significant impact would occur because of faulting, seismically induced ground shaking, seismically induced ground failure, subsidence, erosion, soil expansion, or soil collapse. In addition, no loss to mineral resources would occur because of Modified Project implementation. Therefore, mitigation measures are not required.

3.13.6 Level of Significance After Mitigation

Impacts regarding geology, seismicity, and potentially unstable soils from the Modified Project were determined to be less than significant without mitigation. Therefore, no mitigation measures were required, and the impact level remains less than significant.

Modified Project Site

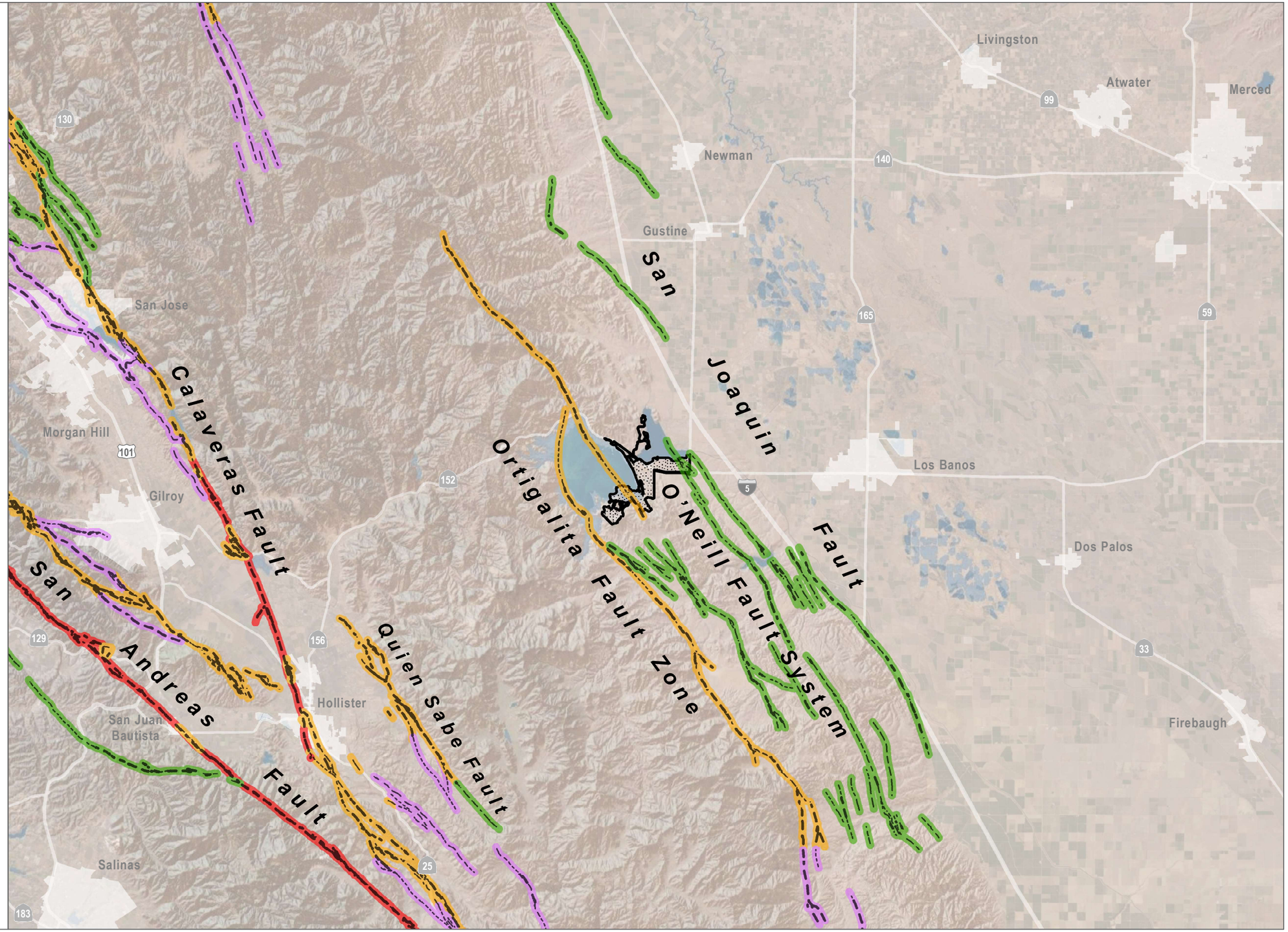
Quaternary Faults

Fault Type

- Inferred
- Moderately constrained
- Well constrained

Fault Age

- Historic
- Holocene
- Late Quaternary
- Quaternary



SOURCE: California Geological Society

DUDEK

0 3 6 Miles

FIGURE 3.13-1

Regional Faulting

B.F. Sisk Dam Safety of Dams Modification Project SEIR

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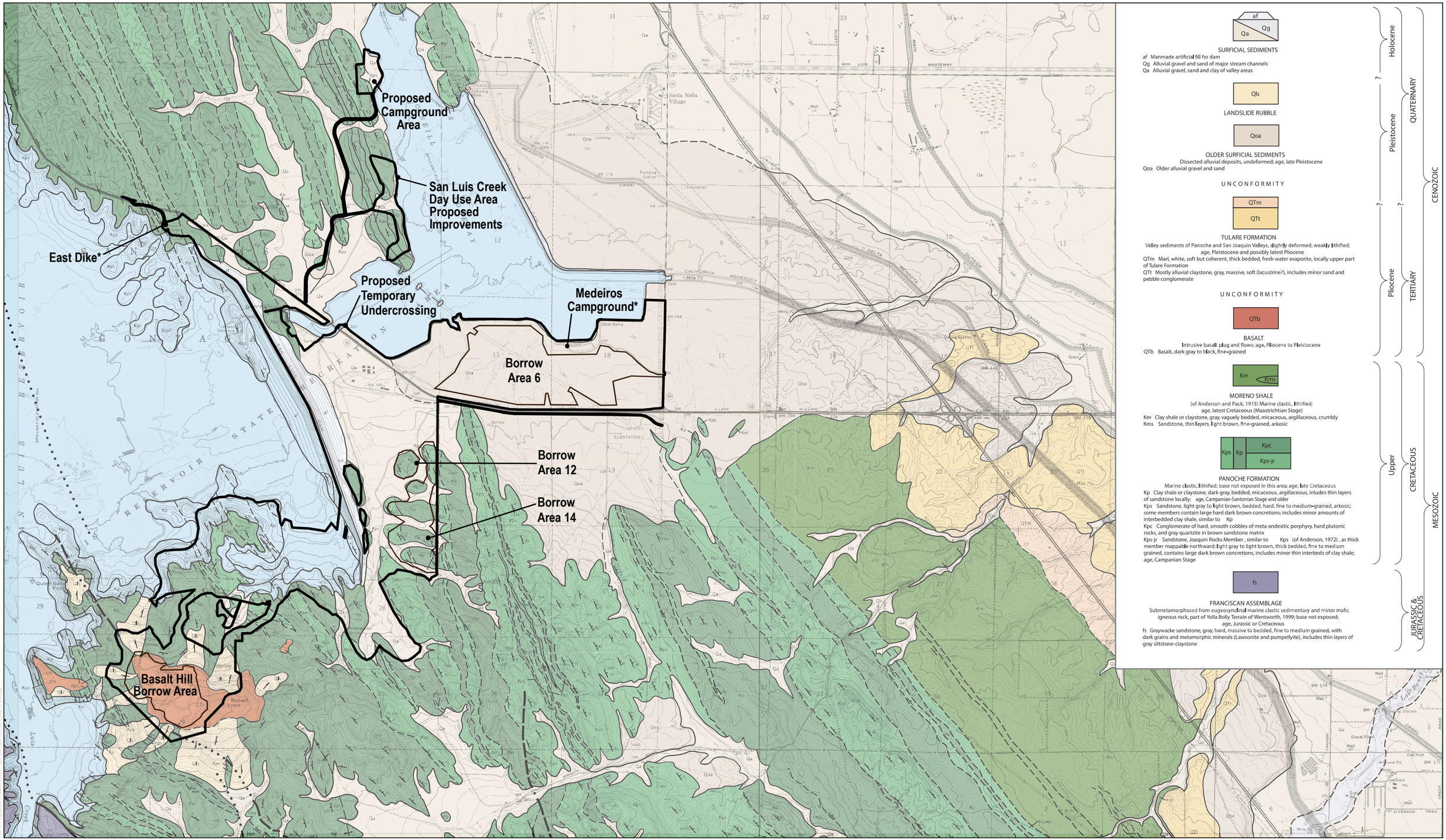

SOURCE: Dibblee 2007

*The 2019 EIS/EIR analyzed impacts of the project within the East Dike and Medeiros Campground area but did not include these are as in mapping of the project footprint. These areas have been added to the Approved Project footprint to correct this mapping omission.

DUDEK

0 2,000 4,000 Feet

FIGURE 3.13-2

Geologic Map

B.F. Sisk Dam Safety of Dams Modification Project SEIR

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Modified Project Site

Quaternary Faults

Fault Type

Inferred

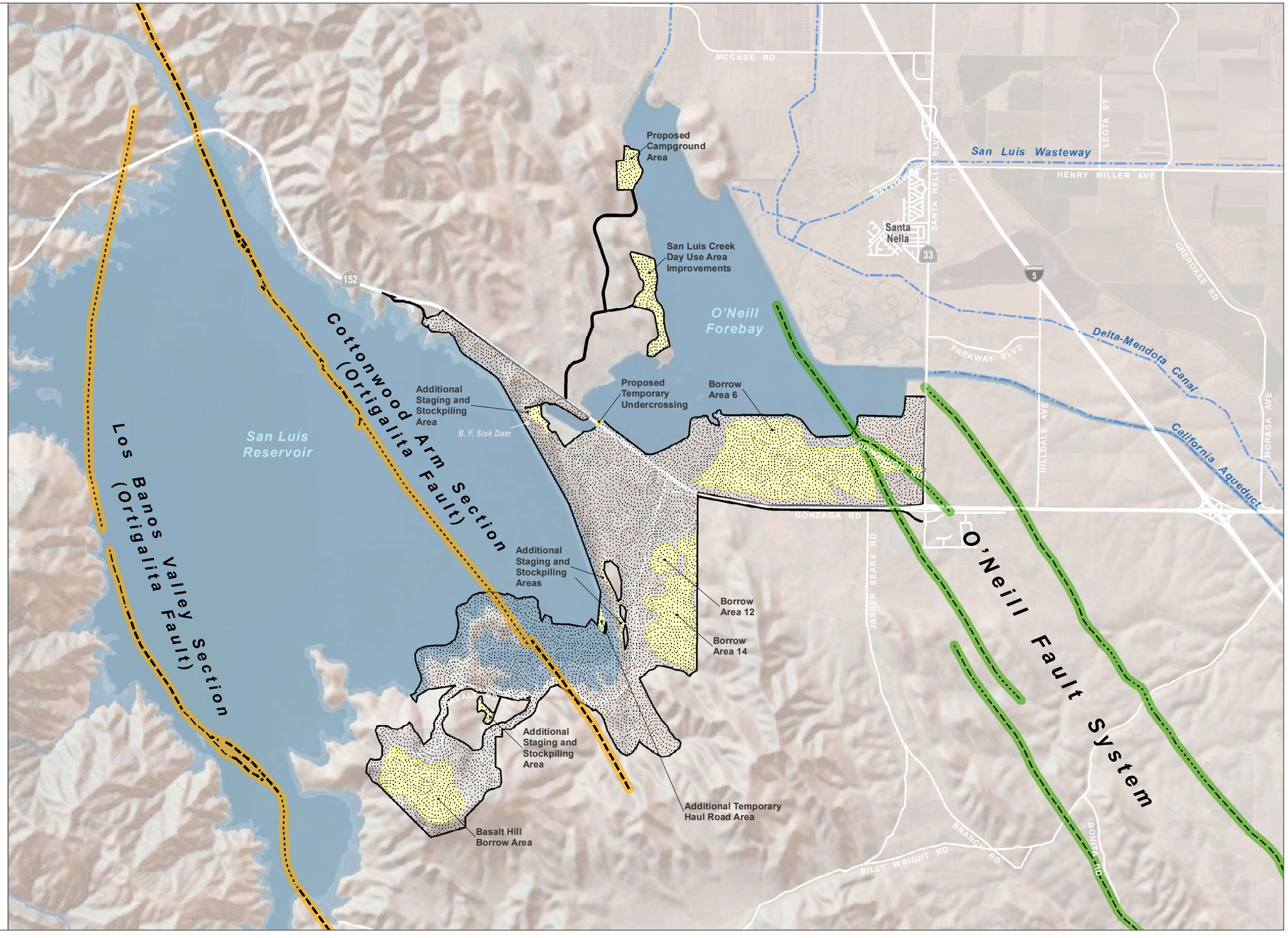
Moderately constrained

Well constrained

Fault Age

Holocene

Late Quaternary



SOURCE: California Geological Society

DUDEK

0 2,300 4,600 Feet

FIGURE 3.13-3

Local Faulting

B.F. Sisk Dam Safety of Dams Modification Project SEIR

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