7.0 Biological Resources – Wildlife

This chapter describes the environmental and regulatory setting for wildlife resources, as well as the environmental consequences associated with construction and operation of Project alternatives, including impacts and mitigation measures.

7.1 Environmental Setting

This section describes the wildlife resources evaluated in this Environmental Impact Statement/Report (EIS/R), including wildlife habitat types and special-status wildlife species. Fish species are discussed separately in Chapter 5.0, “Biological Resources – Fisheries.”

7.1.1 Regional Setting

The Project area lies within the San Joaquin Valley, which comprises the southern portion of California’s Central Valley. The San Joaquin Valley is bounded by the Sierra Nevada mountain range to the east, the Tehachapi Mountains to south, and the Coast Range to the west. With the exception of the Tulare Lake basin, the watersheds of the San Joaquin Valley drain into the San Joaquin River, which leads to the Sacramento-San Joaquin Delta and ultimately into the San Francisco Bay.

The San Joaquin River originates high in the Sierra Nevada. It rapidly descends and exits mountainous terrain in the area now occupied by Friant Dam. The river discharges to the valley floor near Gravelly Ford. Prior to agricultural development, the San Joaquin River and its main tributaries meandered across alluvial fans along the main axis of the San Joaquin Valley floor. The river distributed higher flows into a complex network of sloughs that branched off both sides of the river. It flowed through a flat, homogeneous topography and supported a limited riparian forest. The flat valley floor surrounding the riparian forest often took the form of extensive wetlands, dominated by tule marsh. Riparian forest zones were present along the margins of the primary river channel and were not very extensive (The Bay Institute 1998).

Near Mendota, the San Joaquin River merged with Fresno Slough, a wider and deeper waterway than the San Joaquin River. Fresno Slough was part of an intricate slough system that exchanged water between the Tulare Lake Basin and the San Joaquin River. Downstream from Mendota, the San Joaquin River flowed through a network of large slough channels traversing extensive riparian woodland, tule marshes, and backwater ponds until it joined with the Merced River. Downstream from this point, the floodplain was more confined and the river exhibited a highly sinuous pattern of rapid channel meander, which created a rich complex of oxbow lakes, backwater sloughs, ponds, and sand bars. In its lower sections just upstream from the Delta, the river formed low natural levees approximately 6 feet high (The Bay Institute 1998).

The San Joaquin River has changed dramatically since the early part of the 20th century. The river is now largely confined within constructed levees and bounded by agricultural and urban development, flows are regulated through dams and water diversions, and floodplain habitats have been fragmented and reduced in size and diversity (McBain and Trush 2002). As a result, wildlife habitat has substantially changed from historic conditions. The presence of Friant Dam reduces the frequency of scouring flows; consequently, the vegetation succession of riparian scrub to forest is no longer balanced by periodic loss of forest to the river because of erosion and appearance of new riparian scrub on sand and gravel bars. In addition, operation of Friant Dam has caused gradually declining flows in spring, which are periodically necessary to disperse seed of willows and cottonwoods, and establish seedlings of these riparian tree and shrub species. Drought conditions caused by diversions have also caused a loss of riparian vegetation in several reaches of the river, and urban and agricultural development has caused a gradual loss in the area available for riparian habitat (Bureau of Reclamation 1998).

Federal and State wildlife preserves have been established to conserve, protect, and enhance migratory waterfowl habitat and native ecological communities of the San Joaquin Valley. The Mendota Wildlife Area and the Alkali Sink Ecological Reserve are located approximately 4 miles to the south of the San Joaquin River at River Mile 210. The Alkali Sink Ecological Reserve is home to many sensitive species, including blunt-nosed leopard lizard, palmate-bracted bird's beak, and Hoover's woolly star. The Mendota Wildlife Area, which is hydraulically connected to Fresno Slough, is home to numerous waterfowl and wading birds.

7.1.2 Project Area

The Project area contains 20 wildlife habitat types, including one tree-dominated, three shrub-dominated, five herbaceous-dominated, three aquatic, six developed, and two non-vegetated habitat types (Figure 7-1). The habitat types were classified by vegetative cover type, which is based on vegetation structure and plant species composition. For example, shrub-dominated communities were classified as scrub due to the structure of the vegetation and then further categorized as willow or riparian scrub depending on the dominant plant species present. Generally, the habitat types were defined following the California Wildlife-Habitat Relationships System (WHR) (WHR 2010). In some instances, habitats were defined following Holland (1986) or Moise and Hendrickson (2002), depending on what best represented the habitats within the Project area. Descriptions of each habitat type are provided below.

Table 7-1 lists the habitat types and their acreage within the Project area. Approximately 90 percent of the habitat within the Project area was confirmed through on-site surveys in 2010 and 2011, when Interim Flows had begun to modify 2009 conditions; however, due to restricted access, the remaining area was assessed using aerial photograph interpretation. Additional details regarding wildlife habitats (including survey methods and additional habitat descriptions) are available in the *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Environmental Field Survey Results* (San Joaquin River Restoration Program [SJRRP] 2011a).

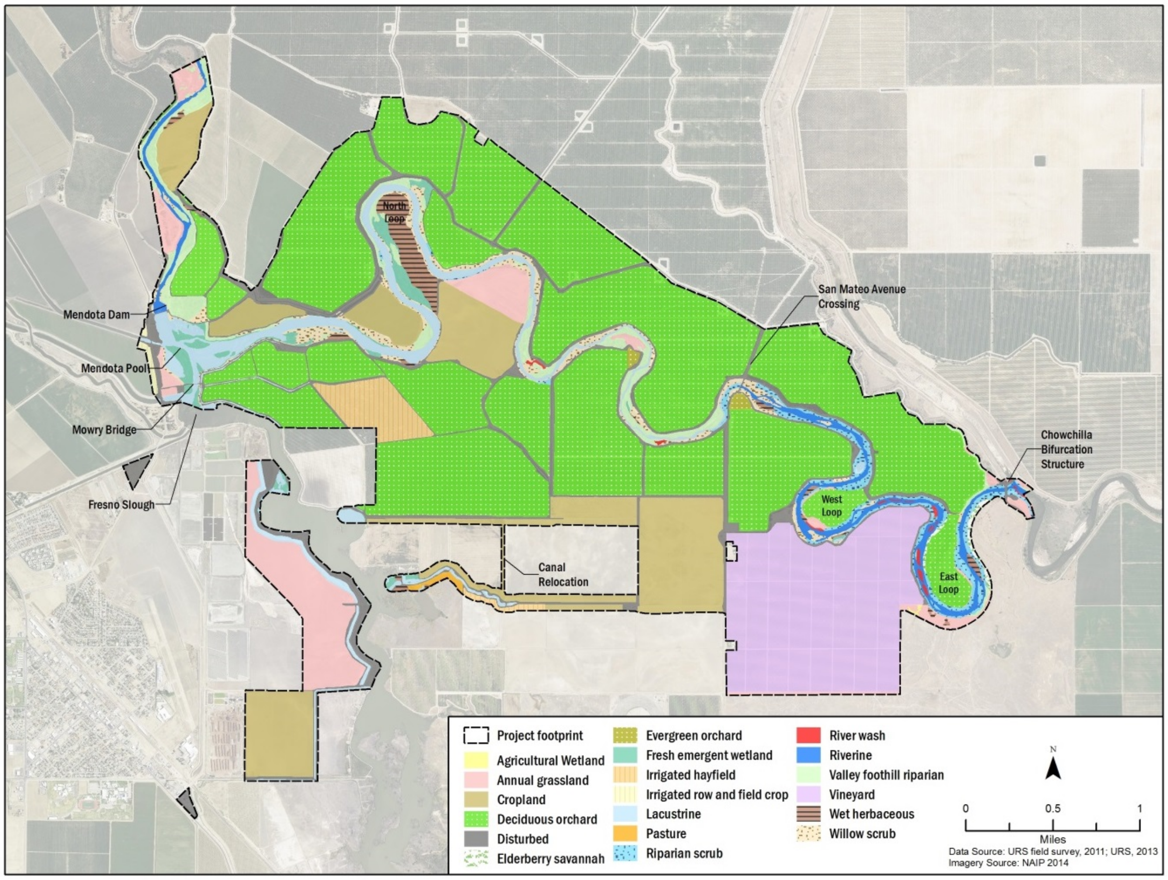

Figure 7-1.
Wildlife Habitat

Table 7-1.
Wildlife Habitat Types Mapped in the Project Area

Category	Habitat Type	Total Area (Acres)
Tree Dominated	Valley foothill riparian	157
Shrub Dominated	Elderberry savannah	12
	Riparian scrub	93
	Willow scrub	122
Herbaceous Dominated	Annual grassland	341
	Fresh emergent wetland	65
	Pasture	8
	River wash	8
	Wet herbaceous	71
Aquatic	Lacustrine	249
	Agricultural wetland	1
	Riverine	97

Table 7-1.
Wildlife Habitat Types Mapped in the Project Area

Category	Habitat Type	Total Area (Acres)
Developed	Cropland	712
	Irrigated hayfield	102
	Irrigated row and field crop	10
	Deciduous orchard	2,769
	Evergreen orchard	10
	Vineyard	624
Non-vegetated	Disturbed	472
Total		5,922

Note: The total acreage value is calculated independently of the specific habitat acreage values; therefore, due to rounding, the value differs slightly from the sum of the habitat acres reported, which is 5,798 acres.

Tree-Dominated Habitats

Valley Foothill Riparian. As described by WHR (2010), valley foothill riparian habitat is characterized by mature riparian forest of winter deciduous trees that is generally associated with areas of floodplains and low-velocity flows with gravely or rocky soils. The typical dominant canopy species in this habitat, within the Project area, is Fremont cottonwood (*Populus fremontii*). Typical dominant subcanopy tree species include Goodding's black willow (*Salix gooddingii*), Oregon ash (*Fraxinus latifolia*), and blue elderberry (*Sambucus mexicana*). Typical understory shrub species include wild rose (*Rosa californica*), buttonbrush (*Cephalanthus occidentalis*), sandbar willow (*Salix exigua*), and, in some areas, California blackberry (*Rubus ursinus*). In the Project area, this habitat type primarily occurs in narrow bands between the river margins and croplands and therefore may be more similar to valley foothill riparian edge habitat (that is, habitat on the edge of a valley foothill riparian forest, as opposed to the interior). Accordingly, cover may be less dense than would be expected in the interior of a stand of valley foothill riparian forest, and the "forest" may appear less mature.

Shrub-Dominated Habitats

Elderberry Savannah. As described by Holland (1986), elderberry savannah habitat is characterized by a winter-deciduous shrub savannah dominated by blue elderberry (*Sambucus mexicana*) and an understory of nonnative grasses. The habitat is generally associated with alluvial soil and areas of floodplains. In natural stands this habitat typically succeeds into riparian vegetation. Typical understory species present in the Project area include tarweed (*Hemizonia* species), mustard (*Brassica* species), California wild rose (*Rosa californica*), and annual grasses.

Riparian Scrub. As described in Moise and Hendrickson (2002), riparian scrub habitat is characterized by a mix of semishrubby perennials and woody vines. In the Project area, some areas also include a layer of shrub-like trees, including tobacco tree (*Nicotiana glauca*), blue elderberry (*Sambucus mexicana*), buttonbrush (*Cephalanthus occidentalis*), sandbar willow (*Salix exigua*), and Goodding's black willow (*Salix gooddingii*).

Common understory species include California wild rose (*Rosa californica*), mugwort (*Artemisia douglasiana*), jimson weed (*Datura* species), cocklebur (*Xanthium strumarium*), nettle (*Urtica dioica*), sunflower (*Helianthus annuus*), tarweed (*Hemizonia* species), mustard (*Brassica* species) and lupin (*Lupinus* species).

Riparian scrub is distinguished from willow scrub habitat, described below, by the fact that riparian scrub is dominated by multiple species (i.e., willow and non-willow riparian species), whereas willow scrub is dominated by stands of willow species. In the Project area, much of the riparian scrub occurs along highly channelized portions of the river or areas that are subject to frequent disturbance.

Willow Scrub. As described by Moise and Hendrickson (2002), willow scrub habitat is characterized by winter deciduous, shrubby, streamside willow thickets that are generally associated with areas subject to flooding or disturbance. Typical dominant species present in the Project area include Goodding's black willow (*Salix gooddingii*) and sandbar willow (*Salix exigua*). Typical understory species include wild rose (*Rosa californica*). In the Project area, much of the willow scrub occurs along sand and gravel bars and in small patches along the banks of the San Joaquin River.

Herbaceous-Dominated Habitats

Annual Grassland. As described by WHR (2010), annual grassland habitat is characterized by open grassland dominated by annual, nonnative grass species that are generally found on flat plains or rolling hills. Typical dominant grass species include wild oats (*Avena fatua*), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), red brome (*Bromus madritensis*), wild barley (*Hordeum marinum*), and foxtail fescue (*Vulpia myuros*). Common forbs typically associated with this habitat include broadleaf filaree (*Erodium botrys*), redstem filaree (*Erodium cicutarium*), turkey mullein (*Eremocarpus setigerus*), true clovers (*Trifolium* species), bur clover (*Medicago minima*), and prickly popcorn flower (*Cryptantha muricata*). Tarweed (*Hemizonia* species) is common in some grassland areas.

In the Project area, annual grassland habitat occurs in several places, including on a less disturbed piece of land in the eastern portion of the Project area, south of the San Joaquin River and adjacent to elderberry savannah and riparian scrub habitat. Other areas mapped as annual grassland typically had a strong ruderal vegetation component.

Fresh Emergent Wetland. As described by WHR (2010), fresh emergent wetland habitat is characterized by erect, rooted, herbaceous, water-intense plants most commonly found on level to gently rolling topography, in depressions or at the edge of rivers or lakes in areas that are flooded frequently. Common species on the upper margins of this habitat in the Project area include yerba mansa (*Anemopsis californica*) and on more alkali sites, saltgrass. Common species on more saturated sites include common cattail (*Typha latifolia*) and tule bulrush (*Scirpus acutus* var. *occidentalis*). Fresh emergent wetland habitat, in the Project area, primarily occurs along the margins of and sometimes as small "islands" within lacustrine habitats, including portions of the San Joaquin River, Fresno Slough, and Little San Joaquin Slough. This habitat type may blend into the wet herbaceous habitat type, described below.

Pasture. As described by WHR (2010), pasture habitat is characterized by irrigated and grazed habitat that consists of a mix of perennial grasses and legumes that provide 100 percent canopy closure planted on flat and gently rolling terrain. Species occurring in this habitat type include Bermuda grass (*Cynodon dactylon*), white melilot (*Melilotus albus*), and ryegrasses (*Lolium* species). Various annual grasses are also present. This habitat type is present south of Little San Joaquin Slough.

Riverwash. As described by Moise and Hendrickson (2002), riverwash habitat is characterized by scoured banks and bars within or adjacent to the active river channel, without significant vegetative cover. In the Project area, this habitat type is present at a few locations along the San Joaquin River.

Wet Herbaceous. Wet herbaceous habitat is characterized by annual and perennial herbaceous vegetation growing in areas with a high water table or subject to frequent flooding. These areas are typically wetter than annual grassland but not wet enough to be classified as fresh emergent wetland. Vegetation is lower-growing than in riparian scrub or valley foothill riparian habitats. Common species occurring in this habitat type include white melilot (*Melilotus albus*), Indian dogbane (*Apocynum cannabinum*), Bermuda grass (*Cynodon dactylon*), ryegrasses (*Lolium* species), tarweed (*Hemizonia* species), and cocklebur (*Xanthium strumarium*). Wet herbaceous habitat in the Project area may blend into other riparian and wetland habitats.

Aquatic Habitats

Agricultural Wetland. In the southeast portion of the Project area, south of the San Joaquin River, there is a water feature that is artificially inundated during the dry season. It is unknown whether this is done intentionally, to water livestock grazed in that area, or unintentionally due to a leaky pipe. Either way, the result is a semi-permanent pond with an unnatural hydroperiod that gets very hot in the summer. This feature may provide drinking water for some wildlife but in general is not considered valuable wildlife habitat and is not expected to support the aquatic life phase of special-status wildlife species.

Lacustrine. As described by WHR (2010), lacustrine habitat is characterized by inland depressions or dammed riverine channels containing standing water. Due to the presence of Mendota Dam, large portions of aquatic habitat in the Project area hold water throughout the summer.

Riverine. As described by WHR (2010), riverine habitat is characterized by intermittent or continually running water of rivers or streams. There are three zones in this habitat type: the open water zone, submerged zone and the shore zone. Riverine habitat is present upstream of the San Mateo Avenue crossing, where water visibly flows.[1] Fresh emergent wetland habitat is mapped separately from riverine habitat, although it may be within the shore or submerged zone as defined by WHR (2010).

[1] Flows observed during the habitat assessment upstream of the San Mateo Avenue crossing surveys are due to Interim Flows.

Developed Habitats

Developed habitats in the Project area consist of agricultural lands, which dominate the area and occur in most portions of the Project area outside of the lands immediately adjacent to the San Joaquin River. Developed habitats are described by WHR (2010) as follows.

Cropland. Cropland habitat is generally characterized by a variety of annual crops, typically grown as a monoculture, which is planted in spring and harvested in summer or fall. In the Project area, an effort was made to define cropland more specifically based on the type of crop, as described below. The more general cropland habitat type was used when a more specific habitat type could not be assigned, such as where agricultural fields were temporarily fallow (this category may include temporary land fallowing/crop idling acreage) or had recently been tilled in preparation for planting a new crop at the time of the habitat assessment surveys. Fallow fields may be regularly tilled or planted with cover crops, which differentiates them from barren habitat (described below). Croplands occur in the Project area both north and south of the river.

Irrigated Hayfield. Irrigated hayfield habitat is characterized by alfalfa fields and grass hayfields where plowing may occur annually but often is less frequent. Alfalfa is typically planted as a monoculture and usually exists unplowed for approximately 3 years or more. Grass hayfields are characterized by irrigated, intensively mowed and managed grass crops with nearly 100 percent cover. In addition, occasionally "native" hayfields are irrigated to enhance their productivity. Native hayfields may include introduced grasses and forbs, but they are managed less intensively and contain a variety of naturally occurring species as well. Irrigated hayfields are found in the western portion of the Project area and near Little San Joaquin Slough.

Irrigated Row and Field Crops. Irrigated row and field crop habitat is characterized by annual or perennial green vegetable crops such as asparagus, broccoli, lettuce, cucumbers, fruits from strawberries to melons, and root vegetables such as carrots, potatoes, and beets. Cotton is also grown as an irrigated row crop. Most of these crops are grown in rows and canopy cover varies from 100 percent to crops with significant bare areas. These crops are also managed in a crop rotation system. See Section 16.1 for a discussion of specific agricultural crops and tree fruits. Irrigated row and field crops occur near the Mendota Dam area.

Deciduous Orchard. Deciduous orchard habitat is characterized by deciduous trees that produce almonds, apples, apricots, cherries, figs, nectarines, peaches, pears, pecans, pistachios, plums, pomegranates, prunes, and walnuts. Deciduous orchards typically consist of a single species of deciduous trees planted in linear, uniformly spaced rows where the crowns typically touch. Orchards in the Project area were clearly managed to reduce understory growth at the time of the habitat assessment and therefore the typical understory of low-growing grasses, legumes, and other herbaceous plants was sparse or absent from this habitat type. See Section 16.1 for a discussion of specific agricultural crops and tree fruits. Deciduous orchards are found in the Project area both north and south of the river.

Evergreen Orchard. Evergreen orchard habitat is characterized by evergreen trees that produce avocados, dates, olives, and citrus fruits. Evergreen orchard habitat typically consists of evergreen trees planted in linear, uniformly spaced rows where crowns typically do not touch. Orchards in the Project area were managed to reduce understory growth at the time of the habitat assessment surveys and therefore the typical understory composed of low-growing grasses, legumes, and other herbaceous plants was sparse or absent from this habitat type. Evergreen orchards are found in the Project area near deciduous orchards at two river bends.

Vineyard. Vineyard habitat is characterized by a single species of vines, usually supported on wood and wire trellises of boysenberries, olallieberries, raspberries, or grapes planted in rows. Typically the ground under the vines is sprayed with herbicides to prevent growth of herbaceous plants, and the ground between the rows of vines is often kept open and grasses or other herbaceous plants may be planted or allowed to grow to control erosion. A vineyard is located in the southeastern portion of the Project area.

Non-vegetated Habitats

Disturbed. As described by Moise and Hendrickson (2002), disturbed habitat is characterized by areas where it is unlikely or impossible to find significant native vegetation, which includes permanent roads or roads at least two lanes in width, canals, levees, structures and associated landscaping, parks, golf courses, active gravel mines or other areas maintained free of vegetation by regular disturbance. This habitat is present throughout the Project area in the form of roads and structures associated with agricultural activities.

7.1.3 Special-Status Wildlife Species

Special-status wildlife species are defined here as wildlife species that meet any of the following requirements.

- Federally-listed as endangered or threatened or proposed for Federal listing under the Federal Endangered Species Act (ESA) (50 Code of Federal Regulations [CFR] 17.11 [listed animals]).
- Federal candidates for possible future listing as threatened or endangered under the ESA (73 Federal Register [FR] 75176, December 10, 2008).
- State listed as endangered or threatened, proposed for State listing, or State candidate for listing under the California Endangered Species Act (CESA) (Cal. Code Regs., tit. 14, § 670.5).
- State fully protected (Fish & G. Code, §§ 3511 [birds], 4700 [mammals], 5050 [amphibians and reptiles]).
- U.S. Fish and Wildlife Service (USFWS) Bird of Conservation Concern species (USFWS 2008).
- California Department of Fish and Wildlife (DFW) Species of Special Concern (DFW 2011).

A total of 36 special-status wildlife species were evaluated for their potential to occur in the Project area. The list of species evaluated was compiled based on a review of all California Natural Diversity Database (CNDDB) records from the Mendota Dam U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle, the eight surrounding quadrangles (Jamesan, Tranquillity, Coit Ranch, Firebaugh, Poso Farm, Firebaugh NE, Bonita Ranch, and Gravelly Ford), and the area within 10 miles of Reach 2B (DFW 2009), as well as a USFWS Sacramento Field Office species list for the Mendota Dam quadrangle (USFWS 2009), and the Audubon Society Important Bird Area species list for the nearby Mendota Wildlife Area (Audubon Society 2009). Based on these sources, relevant field observations, and the presence or absence of suitable habitat, each species was designated as having high, moderate, low, or no potential to occur within the Project area. Special-status wildlife species that are the focus of regional conservation concern or with a moderate or high potential to occur are summarized in Table 7-2. Federally- and State-listed, proposed, candidate and fully protected wildlife species are listed in Table 7-3. Special-status wildlife species that lack ESA or CESA listing status or State fully protected status are listed in Table 7-4. Details regarding suitable habitat for each of these special-status wildlife species and the designations regarding the potential to occur in the Project area are presented and further explained in Mendota Pool Bypass and Reach 2B Improvements Project *Technical Memorandum on Environmental Field Survey Results* (SJRRP 2011a).

Table 7-2.
Special-Status Wildlife Species of Regional Conservation Concern or with a Moderate or High Potential to Occur

Scientific Name	Common Name	Federal Status	State Status
Federally-Listed, State-Listed, and Fully Protected Wildlife Species			
Invertebrates			
Desmocerus californicus dimorphus	valley elderberry longhorn beetle	FT	--
Reptiles and Amphibians			
Gambelia sila	blunt-nosed leopard lizard	FE	SE and FP
Thamnophis gigas	giant garter snake	FT	ST
Birds			
Buteo swainsoni	Swainson's hawk	MBTA	ST
Elanus leucurus	white-tailed kite	MBTA	FP
Grus canadensis tabida	greater sandhill crane	MBTA	FP, ST
Agelaius tricolor	tricolored blackbird	BCC, MBTA	SC, SSC
Mammals			
Dipodomys nitratoides exilis	Fresno kangaroo rat	FE	SE
Other Special-Status Wildlife Species			
Reptiles and Amphibians			
Actinemys marmorata	western pond turtle	--	SSC
Anniella pulchra pulchra	silvery legless lizard	--	SSC
Masticophis flagellum ruddocki	San Joaquin coachwhip	--	SSC
Phrynosoma blainvillii	coast horned lizard	--	SSC
Spea hammondii	western spadefoot	--	SSC

Table 7-2.
Special-Status Wildlife Species of Regional Conservation Concern or with a Moderate or High Potential to Occur

Scientific Name	Common Name	Federal Status	State Status
Birds			
Anser albifrons elgasi	greater white-fronted goose	MBTA	SSC
Asio flammeus	short-eared owl	MBTA	SSC
Athene cunicularia	burrowing owl	BCC, MBTA	SSC
Aythya americana	redhead	MBTA	SSC
Charadrius montanus	mountain plover	BCC, MBTA	SSC
Circus cyaneus	northern harrier	MBTA	SSC
Grus canadensis canadensis	lesser sandhill crane	MBTA	SSC
Lanius ludovicianus	loggerhead shrike	BCC, MBTA	SSC
Numenius americanus	long-billed curlew	BCC, MBTA	--
Pelecanus erythrorhynchos	American white pelican	MBTA	SSC
Xanthocephalus xanthocephalus	yellow-headed blackbird	MBTA	SSC
Mammals			
Eumops perotis californicus	western mastiff bat	--	SSC
Lasiurus blossevillii	western red bat	--	SSC
Taxidea taxus	American badger	--	SSC

U.S. Fish and Wildlife Service and Federal Listing Categories:
BCC = Bird of Conservation Concern
FE = Federally Listed as Endangered
FT = Federally Listed as Threatened
MBTA = Protected under the Migratory Bird Treaty Act

California Department of Fish and Wildlife State Listing Categories:
FP = Fully Protected
SE = State Listed as Endangered
SSC = Species of Special Concern
ST = State Listed as Threatened
SC = Candidate for State Listing

Table 7-3.
Federally- and State-Listed or Fully Protected Wildlife Species

Scientific Name **Common Name**	Federal/ State Status	Preferred Habitat	Potential to Occur in the Project area
Invertebrates			
Branchinecta longiantenna longhorn fairy shrimp	FE/--	Found in vernal pools, particularly clear to turbid grass-bottomed pools and clear-water pools in sandstone depressions.	Low: No suitable habitat observed during habitat assessment surveys. Suitable habitat absent from Project area.
Branchinecta lynchi vernal pool fairy shrimp	FT/--	Found in vernal pools, particularly small, clear-water sandstone depression pools and grassy swale, earth slump, or basalt-flow depression pools.	Low: No suitable habitat observed during habitat assessment surveys. Suitable habitat absent from Project area.

Table 7-3.
Federally- and State-Listed or Fully Protected Wildlife Species

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Desmocerus californicus dimorphus valley elderberry longhorn beetle	FT/--	Elderberry shrubs with stem diameters of 2 to 8 inches. Species always found close to host plant. Larvae may remain in stems for up to 2 years.	Low: Elderberry shrubs abundant in Project area. However, USFWS has redefined the range of the valley elderberry longhorn beetle to exclude the Action Area (USFWS 2015).
Amphibians			
Ambystoma californiense California tiger salamander	FT/ST	Grasslands and understory of valley-foothill hardwood habitats. Require vernal pools or other seasonal water sources for breeding and mammal burrows or other underground refuges.	Low: Project area outside known current and historic range. Suitable habitat absent from Project area.
Rana draytonii California red-legged frog	FT/SSC	Pools with emergent vegetation, typically without predatory fish, and upland hibernacula, such as small mammal burrows or moist leaf litter.	Low: Assumed absent from the Project area and vicinity, based on current known distribution, presence of two invasive ranid frog species, and presence of invasive, predatory fish species.
Reptiles			
Gambelia sila blunt-nosed leopard lizard	FE/SE and FP	Sparsely vegetated alkali and desert scrub habitats, in areas of low topographic relief. Seek cover in mammal burrows, under shrubs or structures such as fence posts.	Low: Limited potentially suitable habitat exists in annual grassland and elderberry savannah located south of the Chowchilla Bifurcation Structure. Occurrence to be confirmed by protocol-level surveys.
Thamnophis gigas giant garter snake	FT/ST	Marshes, low-gradient streams, canals, and irrigation ditches with dense emergent vegetation, water persisting throughout the active period, open areas along water margins, and access to upland habitat for hibernation and escape from flooding.	High: Previously detected in Project area (DFW 2009). Suitable habitat observed in portions of the San Joaquin River affected by Mendota Dam, and in Fresno Slough.

Table 7-3.
Federally- and State-Listed or Fully Protected Wildlife Species

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Birds			
Agelaius tricolor tricolored blackbird	BCC, MBTA/SC, SSC	Typically nests next to open water in freshwater marsh with extensive emergent or riparian vegetation. Breeding colonies also reported in grain fields. Forages in grasslands, wetland habitats, and some agricultural areas.	High: Observed along San Joaquin River corridor during a 19 May 2010 site visit.
Aquila chrysaetos golden eagle	MBTA, GBEPA/FP	Found in rolling hills, mountain areas, sage-juniper flats, or deserts. Forages in open areas with low vegetation. Nests on cliff faces or in large trees.	Low: No eagles or suitable eagle nesting habitat observed during habitat assessment survey. May occur during foraging or wintering but nesting not expected.
Buteo swainsoni Swainson's hawk	MBTA/ST	Nests in riparian areas, oak woodlands, and isolated and roadside trees close to grassland or agricultural foraging habitat.	High: Swainson's hawk nests previously documented in Project area (DFW 2009). Two pairs present in Project area during habitat assessment survey.
Coccyzus americanus occidentalis western yellow-billed cuckoo	FC, BCC, MBTA/SE	Large blocks of riparian habitats (particularly woodlands with willow and cottonwood) along floodplains of larger river systems. Dense understory foliage important.	Low: Project area located outside of current known range. Suitable habitat limited and not observed during habitat assessment survey. Not likely to occur due to extended absence from the region.
Elanus leucurus white-tailed kite	MBTA/FP	Prefers grasslands, oak woodlands, riparian scrub, and savannas. Forages in wetland and grassland areas.	High: Species observed in the Project area during valley elderberry longhorn beetle surveys.
Grus canadensis tabida greater sandhill crane	MBTA/FP, ST	Nests in wet meadows and emergent marshes. Forages in wet meadows, marshes, freshwater margins, and less frequently grasslands and croplands.	High: Sandhill cranes observed flying nearby during valley elderberry longhorn beetle protocol survey –may be different subspecies. Likely an uncommon visitor during nonnesting season.
Riparia riparia bank swallow	MBTA/ST	Colonial nester primarily in riparian and other lowland habitats west of the desert. Requires vertical banks/cliffs with fine-textured/sandy soils near water to dig nest cavity.	Low: No suitable nesting habitat observed during habitat assessment survey. Suitable nesting habitat no longer present at historic Mendota Pool occurrence location.
Vireo bellii pusillus Least Bell's vireo	FE/SE/ MBTA	Nests in riparian woodlands, especially willows and other shrubs, along low elevation riverine areas. Forages in riparian and adjacent uplands.	Low: No individuals were found during protocol surveys. Nearest known occurrence is San Luis Reservoir (approximately 55 miles northwest)

Table 7-3.
Federally- and State-Listed or Fully Protected Wildlife Species

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Mammals			
Ammospermophilus nelsoni Nelson's antelope squirrel	--/ST	Merced County south to Kings, Tulare and Kern counties, at elevations ranging from 200 to 1,200 feet. Dry, sparsely vegetated loam soils with widely scattered shrubs, forbs, and grasses in broken terrain with gullies and washes.	Low: Species not observed during habitat assessment survey, although California ground squirrels were observed. Project area is north of current range of this species.
Dipodomys nitratoides exilis Fresno kangaroo rat	FE/SE	Restricted to native grasslands in Fresno County within the San Joaquin Valley; nearly level, light, friable soils in chenopod scrub and grassland communities.	Low: Despite efforts to trap this species, it has not been detected at nearby sites where it was present in 1992. Kangaroo rat sign (e.g., tail drags, potential burrows) was observed in the Project area (primarily east and west loops prior to agricultural conversion), although 2011 trapping efforts within the Project area captured only Heermann's kangaroo rat. Limited potentially suitable habitat exists in the Project area in annual grassland and elderberry savannah located south of the Chowchilla Bifurcation Structure. Occurrence to be confirmed by protocol-level surveys.
Vulpes macrotis mutica San Joaquin kit fox	FE/ST	Grassland or grassy open stages with scattered shrubby vegetation; requires loose-textured sandy soils for burrowing; requires suitable prey base of small rodents.	Low: Although habitat potentially offering denning and foraging opportunities was observed during the habitat assessment survey, sign was not observed and prior surveys in portions of the Project area have failed to confirm the presence of this species.

U.S. Fish and Wildlife Service and Federal Listing Categories:
BCC = Bird of Conservation Concern
FC = Candidate for Federal Listing
FD = Federally Delisted
FE = Federally Listed as Endangered
FT = Federally Listed as Threatened
GBEPA = Protected under the Golden and Bald Eagle Protection Act
MBTA = Protected under the Migratory Bird Treaty Act

California Department of Fish and Game State Listing Categories:
FP = Fully Protected
SC = Candidate for State Listing
SE = State Listed as Endangered
SSC = Species of Special Concern
ST = State Listed as Threatened

**Table 7-4.
Other Special-Status Wildlife Species**

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Amphibians			
Spea hammondii western spadefoot	--/SSC	Grassland and valley-foothill hardwood woodlands, vernal pools or seasonal wetlands are essential for egg laying.	Moderate: Agricultural wetland in annual grassland and elderberry savannah located south of the Chowchilla Bifurcation Structure has some potential to provide breeding habitat.
Reptiles			
Actinemys marmorata western pond turtle	--/SSC	Ponds, marshes, rivers, streams, irrigation ditches, and vernal pools; with basking sites and suitable upland habit for egg laying.	High: Species observed in the Project area during habitat assessment survey, including likely nest.
Anniella pulchra pulchra silvery legless lizard	--/SSC	Sand dunes or sandy soil, with litter; also wooded stream edges, and occasionally desert-scrub. Bush lupine often indicates suitable conditions. Found in leaf litter, under rocks, logs, and driftwood.	High: Species known from immediately adjacent to the Project area and suitable habitat present at various locations in the Project area.
Masticophis flagellum ruddocki San Joaquin whipsnake	--/SSC	Open, dry, treeless areas, including grassland and saltbush scrub. Takes refuge in rodent burrows, under shaded vegetation, and under surface objects.	High: Recent nearby occurrences and suitable habitat present in the Project area.
Phrynosoma blainvillii coast horned lizard	--/SSC	Coastal sage, chaparral, and other brushy, shrubby vegetation habitats that provide a low shrub structure; Overwinters in small mammal burrows.	High: Recent nearby occurrences, suitable habitat and some native ant colonies present in the Project area.
Birds			
Accipiter cooperii Cooper's hawk	MBTA/WL	Typically found in patchy woodlands. Nests and forages near open water and wetland vegetation.	High: Observed along San Joaquin River corridor during habitat assessment survey.
Anser albifrons elgasi greater white-fronted goose	MBTA/SSC	Prefers moist and wet environments, including freshwater wetlands, croplands, and pastures. Breeds in Alaska.	High: Likely present during winter and migratory periods. August habitat assessment survey did not provide opportunity to observe this species.
Asio flammeus short-eared owl	MBTA/SSC	Open grasslands, prairies, dunes, irrigated fields, and wetlands. Nests on the ground in tall grass stands.	High: Observed along San Joaquin River corridor during habitat assessment survey and during valley elderberry longhorn beetle surveys.

**Table 7-4.
Other Special-Status Wildlife Species**

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Athene cunicularia burrowing owl	BCC, MBTA/SSC	Open, dry, annual or perennial grasslands, deserts, and scrublands characterized by low-growing vegetation, with small mammal burrows for nesting and roosting.	Moderate: Observed flying just north of the Project area. Suitable habitat is present within the Project area, but no sign of this species was observed during wildlife habitat assessment survey.
Aythya americana redhead	MBTA/SSC	Nests near freshwater emergent wetlands and areas of deep, open water.	Moderate: Although suitable habitat is present in the Project area, this species was not observed during the habitat assessment survey.
Charadrius montanus mountain plover	BCC, MBTA/SSC	Roosts and forages in short grasslands, freshly plowed fields, and bare ground with flat topography. Prefers fallow, grazed, or burned areas and alkali flats with burrowing rodents.	Moderate: Potential wintering and foraging habitat is present in the Project area.
Circus cyaneus northern harrier	MBTA/SSC	Nests and forages in open habitats including freshwater marshes and weedy edges of rivers and streams. Also found in agricultural areas such as pastures and some croplands.	High: Observed along San Joaquin River corridor during habitat assessment survey.
Falco columbarius merlin	MBTA/WL	Occurs in coast, grasslands, savannas, woodlands, coniferous forests, wetlands, and occasionally desert habitats. Requires dense tree stands near bodies of water.	High: Observed in Project area near Fresno Slough during valley elderberry longhorn beetle protocol surveys.
Grus canadensis canadensis lesser sandhill crane	MBTA/SSC	Forages in agricultural fields, pastures, and mowed to grazed grasslands. Roosts in shallow water within wetland habitats.	Moderate: Potential wintering and foraging habitat is present in the Project area.
Lanius ludovicianus loggerhead shrike	BCC, MBTA/SSC	Breeds in shrubland or open woodlands. Requires tall shrubs/trees for hunting perches and nests. Uses riparian edges in the Central Valley.	High: Observed along San Joaquin River corridor during habitat assessment survey.
Larus californicus California gull	MBTA/WL	Preferred inland habitat includes riverine, lacustrine, and cropland habitats.	Moderate: Potential wintering and foraging habitat is present in the Project area. Observed flying over the Project area.
Numenius americanus long-billed curlew	BCC, MBTA/WL	Winters in upland herbaceous areas and croplands.	High: Observed in the Project area during valley elderberry longhorn beetle surveys. Potential wintering and foraging habitat is present in the Project area.

Table 7-4.
Other Special-Status Wildlife Species

Scientific Name **Common Name**	**Federal/ State Status**	**Preferred Habitat**	**Potential to Occur in the Project area**
Pandion haliaetus osprey	MBTA/WL	Found near large, open, fish-bearing waters. Nests and roosts on large tree, snags, and cliffs.	Moderate: Potential wintering and foraging habitat is present in the Project area.
Pelecanus erythrorhynchos American white pelican	MBTA/SSC	Forages in shallow inland waters such as marshes, canals and lake or river edges.	High: Observed at Mendota Pool during habitat assessment survey.
Phalacrocorax auritus double-crested cormorant	MBTA/WL	Found in riverine habitats within the Central Valley.	High: Observed at Mendota Pool during habitat assessment survey.
Plegadis chihi white-faced ibis (rookery site)	MBTA/WL	Forages in emergent freshwater wetlands and flooded croplands/pastures. Roosts in dense wetland vegetation.	Moderate: Observed flying over the Project area. Potential rookery and foraging habitat present in the Project area.
Xanthocephalus xanthocephalus yellow-headed blackbird	MBTA/SSC	Nests in marshes with tall emergent vegetation and areas of relatively deep water.	High: Observed along San Joaquin River corridor and Fresno Slough during valley elderberry longhorn beetle protocol surveys.
Mammals			
Eumops perotis californicus western mastiff bat	--/SSC	Roosts in crevices in cliff faces, high buildings, and tunnels; forages in arid, semi-arid habitat-coniferous and deciduous woodlands, coastal scrub, grasslands, and chaparral.	High: Although evidence of roosting habitat was not observed during the habitat assessment survey, may forage over much of the Project area.
Lasiurus blossevillii western red bat	--/SSC	Roosts primarily in trees, typically adjacent to open fields or streams, which are protected above and open below for foraging; prefers habitat edges and mosaics with trees.	High: May roost in trees in riparian habitat in the Project area, and may forage over much of the Project area.
Taxidea taxus American badger	--/SSC	Grasslands, savannas, and mountain meadows; require friable soils, and relatively open, uncultivated ground; requires suitable prey base of burrowing rodents.	Moderate: Although potentially suitable habitat is present in the Project area, no sign of this species was observed during the habitat assessment survey.

Key:

U.S. Fish and Wildlife Service and Federal Listing Categories:
BCC = Bird of Conservation Concern
FC = Candidate for Federal Listing
FD = Federally Delisted
FE = Federally Listed as Endangered
FT = Federally Listed as Threatened
MBTA = Protected under the Migratory Bird Treaty Act

California Department of Fish and Game State Listing Categories:
FP = Fully Protected
SC = Candidate for State Listing
SE = State Listed as Endangered
SSC = Species of Special Concern
ST = State Listed as Threatened
WL = Watch List

7.2 Regulatory Setting

7.2.1 Federal

The following subsections describe Federal laws and regulations governing the protection of wildlife resources.

Federal Endangered Species Act of 1973

The ESA (16 United States Code [USC] Sections 1531 to 1543) and subsequent amendments provide guidance for the conservation of Federally-listed species and the ecosystems on which they depend.

Prohibited Acts. Section 9 of the ESA prohibits the "take" of any fish or wildlife species listed under the ESA unless otherwise authorized by Federal regulations. The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 USC Section 1532:19). Two processes whereby take is allowed when it is incidental to an otherwise legal activity are described in Section 7 and Section 10, respectively. Section 9 of the ESA also prohibits the unlawful removal, damage or destruction of any endangered plant under Federal jurisdiction, or where in non-Federal areas, in knowing violation of any State law.

Interagency Consultation and Biological Assessments. Section 7 of the ESA provides a means for authorizing the "take" of threatened or endangered species by Federal agencies, and applies to actions that are conducted, permitted, or funded by a Federal agency. The statute requires Federal agencies to consult with the USFWS or National Marine Fisheries Service (NMFS), as appropriate, to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of critical habitat for these species. If a proposed project "may affect" a listed species or destroy or modify critical habitat, the lead agency is required to prepare a biological assessment evaluating the nature and severity of the potential effect.

Habitat Conservation Plans. Section 10 of the ESA requires that non-Federal landowners obtaining an Incidental Take Permit from the USFWS for activities that might incidentally harm (or "take") endangered or threatened wildlife on their land. To obtain a permit, an applicant must develop a Habitat Conservation Plan that is designed to offset any harmful impacts the proposed activity might have on the species.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC Sections 661 to 667e et seq.) applies to any Federal project where any body of water is impounded, diverted, deepened, or otherwise modified. Project proponents are required to coordinate with USFWS and/or NMFS and the appropriate State wildlife agency.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA; USC Sections 703 to 712) makes it unlawful unless expressly authorized by permit pursuant to Federal regulations to "pursue, hunt, take, capture, kill, attempt to take, capture or kill, offer for sale, sell, offer to purchase,

purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export at any time, or in any manner, any migratory bird, or any part, nest, or egg of any such bird."

This includes direct and indirect acts with the exception of harassment and habitat modification, which are not included unless they result in direct loss of birds, nests, or eggs. Most bird species occurring in California fall under the protection of the MBTA except those species that belong to the families not listed in any of the four treaties, such as wrentit (*Chamaea fasciata*), European starling (*Sturnus vulgaris*), California quail (*Callipepla californica*), ring-necked pheasant (*Phasianus colchicus*), and chukar (*Alectoris chukar*), among others less common in California. The MBTA is administered by USFWS Division of Migratory Bird Management.

The Migratory Bird Treaty Reform Act (Division E, Title I, Section 143 of the Consolidated Appropriations Act, 2005, Public Law 108–447) amends the MBTA (16 USC Sections 703 to 712) such that nonnative birds or birds that have been introduced by humans to the United States or its territories are excluded from protection under the Act. It defines a native migratory bird as a species present in the United States and its territories as a result of natural biological or ecological processes. This list excluded two additional species commonly observed in the United States, the rock dove (*Columba livia*) and domestic goose (*Anser domesticus*).

Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (16 USC 668-668d, 54 Stat. 250) as amended, provides protection for the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) by prohibiting the taking, possession, and commerce of such birds, their nests, eggs, or feathers unless expressly authorized by permit pursuant to Federal regulations.

Protection of Migratory Bird Populations (Executive Order 13186)

Executive Order 13186 directs each Federal agency taking actions that have or may have adverse impacts on migratory bird populations to work with the USFWS to develop a memorandum of understanding that would promote the conservation of migratory bird populations. This includes avoiding and minimizing adverse impacts on migratory bird resources when conducting agency actions, restoring and enhancing migratory bird habitats, and preventing or abating the pollution or detrimental alteration of the environment for the benefit of migratory birds.

7.2.2 State of California

The following subsections describe State laws and regulations governing the protection of biological resources.

California Endangered Species Act

The CESA (Fish & G. Code, §§ 2050 to 2085) establishes the State policy to conserve, protect, restore, and enhance threatened or endangered species and their habitats by protecting "all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation." Animal species are listed by DFW as threatened or endangered, and plants are listed as rare, threatened, or endangered. However, only those plant species listed as threatened or endangered receive protection under the CESA.

The CESA mandates that State agencies do not approve a project that would jeopardize the continued existence of these species if reasonable and prudent alternatives are available that would avoid a jeopardy finding. There are no State agency consultation procedures under the CESA. For projects that would affect a species that is Federally- and State-listed, compliance with ESA satisfies the CESA if DFW determines that the Federal incidental take authorization is consistent with the CESA under Section 2080.1. For projects that would result in take of a species that is State listed only, the project sponsor must apply for a take permit, in accordance with Section 2081, subdivision (b).

Fully Protected Species

Four sections of the Fish and Game Code (§§ 3511, 4700, 5050, and 5515) list 37 fully protected species. These sections prohibit take or possession "at any time" of the species listed, with few exceptions, and state that "no provision of this code or any other law will be construed to authorize the issuance of permits or licenses to 'take' the species," and that no previously issued permits or licenses for take of the species "shall have any force or effect" for authorizing take or possession.

Bird Nesting Protections

Bird nesting protections in the Fish and Game Code (§§ 3503, 3503.5, 3511, and 3513) include the following.

- Section 3503 prohibits the take, possession, or needless destruction of the nest or eggs of any bird.
- Section 3503.5 prohibits the take, possession, or needless destruction of any nests, eggs, or birds in the orders Falconiformes (new world vultures, hawks, eagles, ospreys, and falcons, among others), or Strigiformes (owls).
- Section 3511 prohibits the take or possession of fully protected birds.
- Section 3513 prohibits the take or possession of any migratory nongame bird, or part thereof, as designated in the MBTA.

To avoid violation of the take provisions, it is generally required that project-related disturbance at active nesting territories be reduced or eliminated during the nesting cycle.

Lake and Streambed Alteration

Fish and Game Code section 1600 et seq. requires DFW to be notified before any project activity that would do any of the following.

- Substantially divert or obstruct the natural flow of any river, stream, or lake.
- Substantially change or use any material from the bed, channel, or bank of any river, stream, or lake.

- Deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake.

The Lake and Streambed Alteration notification requirement applies to work undertaken in or near a river, stream, or lake that flows at least intermittently through a bed or channel. This includes ephemeral streams, desert washes, and watercourses with subsurface flow. It may also apply to work undertaken in the floodplain. Preliminary notification and project review generally occur during the environmental process.

When an existing fish or wildlife resource may be substantially adversely affected, DFW proposes reasonable modifications to the project to protect the resources. These modifications, or conditions, are formalized in a Lake or Streambed Alteration Agreement that becomes part of the plans, specifications, and bid documents for the project.

Natural Communities Conservation Planning Act

This act was enacted to encourage broad-based planning to provide for effective protection and conservation of the State's wildlife resources while continuing to allow appropriate development and growth (Fish & G. Code, §§ 2800 to 2835). Natural Community Conservation Plans may be implemented, which identify measures necessary to conserve and manage natural biological diversity within the planning area, while allowing compatible and appropriate economic development, growth, and other human uses.

7.2.3 Regional and Local

The following subsections describe the regional and local regulations governing the protection of wildlife resources.

San Joaquin River Management Program

The San Joaquin River Management Program was authorized by Assembly Bill (AB) 3603 and signed by the governor on September 18, 1990. Specific issues addressed by San Joaquin River Management Program include flood protection, water supply, water quality, recreation, fisheries, and wildlife. San Joaquin River Management Program produced a report in 1995, outlining recommendations in the form of projects, studies, and acquisitions.

Central Valley Joint Venture

The Central Valley Joint Venture is a self-directed coalition consisting of 20 Federal and State agencies and private conservation organizations. This partnership directs its efforts toward the common goal of providing for the habitat needs of migrating and resident birds in the Central Valley of California. The Central Valley Joint Venture was established in 1988 as a regional partnership focused on the conservation of waterfowl and wetlands under the North American Waterfowl Management Plan. It has since broadened its focus to the conservation of habitats for other birds, consistent with major national and international bird conservation plans and the North American Bird Conservation Initiative. The Central Valley Joint Venture Implementation Plan (2006) has identified specific goals and objectives for conservation activities for waterfowl, shorebirds, waterbirds, and riparian songbirds.

Fresno County General Plan

The Open Space and Conservation Element of the Fresno County General Plan (Fresno County 2000) outlines several policies designed to protect wildlife and their habitat. These policies include the following.

- Policies OS-D.4 through OS-D.6 require the protection of wetlands, riparian areas, and the adjacent upland habitats.
- Policies OS-E.1 through OS-E.18 require the protection of wildlife habitats and movement and migration corridors through construction buffers, management practices, conservation plans, pest control, pesticide use monitoring, and conservation.

Madera County General Plan

The Madera County General Plan Policy Document (Madera County 1995) outlines several policies designed to protect wildlife and their habitat in the Agricultural and Natural Resources section of the plan. These policies include the following.

- Policies 5.D.4 through 5.D.6 require the protection of wetlands, riparian areas, and the adjacent upland habitats.
- Policies 5.E.1through 5.E.10 require the identification and protection of wildlife habitats, including habitat for rare, threatened, endangered, and indigenous species, through management practices, monitoring of pesticide use, ground squirrel control, environmental review processes, and conservation.

7.3 Environmental Consequences and Mitigation Measures

7.3.1 Impact Assessment Methodology

This section describes the methods used to evaluate potential impacts to wildlife resources. First described are the background reviews and field surveys which were used or conducted to identify wildlife resources that may be impacted by the Project. The specific methods that were used to determine Project impacts are then described.

Identification of Wildlife Resources in the Project Area

Wildlife resources potentially occurring in the Project area were identified through queries of existing databases and agency information and by field surveys. Three primary databases were reviewed to obtain special-status wildlife species occurrence data from within the Project area and vicinity: CNDDB (DFW 2009), USFWS Sacramento Field Office Species List (USFWS 2009), and Audubon Society Important Bird Area species list for the Mendota Wildlife Area (Audubon Society 2009). These and other sources of information used are described in detail in the Mendota Pool Bypass and Reach 2B Improvements Project *Technical Memorandum on Environmental Survey Results* (SJRRP 2011a, Section 3).

Wildlife habitat assessment surveys were conducted to identify and map habitats present within the Project area and to record direct and indirect wildlife observations. These surveys were conducted in the Project area from August 23 through 27, 2010 and April 28 through 30, 2015. With the exception of developed agricultural areas, surveys were conducted on foot throughout portions of the Project area where access to private- or publicly-owned property had been granted, primarily parcels located south of the San Joaquin River. In developed agricultural areas and where foot surveys were not possible, either because vegetation was too dense or access was not granted, “windshield surveys” were done largely by a biologist observing from a car. For these windshield surveys, the field team used binoculars and a spotting scope to observe habitat features and wildlife from the public road. More than 90 percent of the habitat within the Project area was confirmed through on-site surveys.

Supplemental focused surveys were conducted for birds, valley elderberry longhorn beetle, and small mammals. A post-breeding season bird survey was conducted on August 26, 2010, and an early breeding season bird survey was conducted on March 3, 2011. Additional surveys were conducted in 2014. Protocol level surveys were conducted for valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) March 1, 2011 through March 4, 2011 and March 8, 2011 through March 9, 2011 according to the protocol established by USFWS in Conservation Guidelines for the Valley Elderberry Longhorn Beetle (USFWS 1999) in applicable areas with authorized site access. Small mammal trapping, focused on detection of Fresno kangaroo rat (*Dipodomys nitratoides exilis*), was conducted during summer 2011 in applicable areas with authorized site access.

Habitat data collected during the habitat assessment surveys were used in combination with existing data and aerial photograph interpretation to map wildlife habitats throughout the Project area. The habitat types were largely defined according to the California Wildlife-Habitat Relationships System (WHR 2010); however, certain habitats were also defined using Holland (1986) and Moise and Hendrickson (2002), where appropriate. Additional description of field surveys and habitat mapping are presented in the Mendota Pool Bypass and Reach 2B Improvements Project *Technical Memorandum on Environmental Survey Results* (SJRRP 2011a, Section 3).

The assessment of wildlife resources would be amended when access to the entire Project area is granted, or following additional surveys, should they be implemented before land acquisition. Surveys may determine that habitat for special-status species is not present in the Project area. For certain target species, protocol-level surveys may be conducted; if target species are not encountered, a species may be considered absent with agency approval. In these situations, impacts to those wildlife resources would not exist and implementation of the conservation measures for the protected species would no longer be required.

Impact Evaluation Methodology

The evaluation of potential impacts to wildlife resources used in the alternatives analysis is both quantitative and qualitative in nature. Wherever possible, quantitative analyses were used to determine the acres of potential habitat lost or altered for each special-status wildlife species as a result of the Project. Included in this analysis was direct habitat loss that would occur as a result of Project construction activities including grading, levee construction, and the placement of fill, and indirect habitat loss that would result from new hydrologic patterns that may over time alter existing vegetation and habitats.

To calculate these impacts, geographic information system data were used to create a master habitat layer, based on the wildlife habitat mapping effort described above, to estimate the location and area of potential habitat present within the Project area under existing conditions. Most species-specific impact calculations were generated by intersecting Project impact layers with the appropriate habitat types for each species. This methodology was used to generate impact numbers for each species for each alternative.

Species that were not analyzed using this methodology included valley elderberry longhorn beetle, blunt-nosed leopard lizard, giant garter snake, western pond turtle, and Fresno kangaroo rat. Potential impacts due to habitat loss for valley elderberry longhorn beetle were estimated based on a count of elderberry shrubs affected by each alternative. The analysis of blunt-nosed leopard lizard and Fresno kangaroo rat habitat loss included the results of species-specific habitat surveys. Habitat loss for giant garter snake and western pond turtle were assessed using the distribution of their aquatic habitats and an associated 200-foot upland buffer.

Potential impacts were also evaluated qualitatively for individual special-status wildlife species and potential wildlife habitat. Examples of impacts that were evaluated qualitatively include noise, motion and startle, dust, and changes in hydrology.

7.3.2 Significance Criteria

For impacts to wildlife resources, the thresholds of significance are based on Appendix G of the State California Environmental Quality Act (CEQA) Guidelines. Under National Environmental Policy Act (NEPA) Council on Environmental Quality (CEQ) Regulations, effects to wildlife resources were evaluated in terms of their context and intensity. The Project would result in a significant impact on wildlife resources if it would do any of the following.

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by DFW or USFWS.
- Interfere substantially with the movement of any native resident or migratory wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
- Conflict with the provisions of an adopted habitat conservation plan, Natural Communities Conservation Plan, or other approved State, regional or local habitat conservation plans.

7.3.3 Impacts and Mitigation Measures

This section provides a project-level evaluation of direct and indirect effects of the Project Alternatives on wildlife resources. It includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. The analysis is organized by Project alternative with specific impact topics numbered sequentially under each alternative. With respect to wildlife, the environmental impact issues and concerns are:

1. Project Effects on Special-Status Invertebrate Species.
2. Project Effects on Special-Status Reptile and Amphibian Species.
3. Project Effects on Special-Status Bird Species.
4. Project Effects on Special-Status Mammal Species.
5. Project Effects on Wildlife Movement Corridors.
6. Long-term Habitat Improvement in Reach 2B.

Other wildlife-related issues covered in the Program Environmental Impact Statement/Report (PEIS/R) (SJRRP 2011b) are not covered here because they are programmatic in nature and/or are not relevant to the Project area.

Issues Eliminated from Further Analysis

Recovery Areas and Designated Critical Habitat. Recovery plans are non-regulatory documents developed by the USFWS to provide guidance for the recovery of threatened or endangered species. Recovery plans typically identify recovery or core areas that are important to the survival and recovery of a species. Critical habitat is a term defined and used in the ESA that refers to a specific geographic area that contains features essential for the conservation of a threatened or endangered species and that may require special management and protection.

San Joaquin Kit Fox Recovery Area. The *Recovery Plan for the Upland Species of the San Joaquin Valley, California* (USFWS 1998) identifies recovery areas for the San Joaquin kit fox. These areas are mapped and named in the *San Joaquin Kit Fox (Vulpes macrotis mutica) 5-Year Review: Summary and Evaluation* (USFWS 2010). The Project area overlaps with Satellite Area 4: Western Madera County. Although the 5-Year Review states that the species is presumed to be extirpated from this area (locally extinct) (USFWS 2010), USFWS has indicated in Project-related correspondence that this is a mistake in the 5-Year Review. USFWS has clarified that they do not presume kit fox extirpated from the region (Raabe, pers. comm. 2015). DFW, the organization that manages the Alkali Sink Ecological Reserve located approximately 2 miles south of the Project area, does not know of any resident population at the reserve, but points out it could be used for dispersal or foraging (Espino, pers. comm., 2015). However, when surveyed for other species there has been no sign of kit fox observed at the Alkali Ecological Reserve. Surveys have failed to confirm the presence of this species in the Project area and vicinity and Project activities are not expected to have any adverse impact to San Joaquin kit fox recovery areas. Therefore, conflicts with this recovery plan are not further addressed in this document.

Vernal Pool Recovery Area. The *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005) identifies 16 vernal pool regions that contain 41 core areas, which are considered critical to the preservation and recovery of one or more vernal pool species addressed by the plan. The Project area overlaps with the San Joaquin Valley vernal pool region but does not overlap with any of the core areas. Project activities are not expected to have any impact to core vernal pool recovery areas; and therefore, this issue is not further addressed in this document.

Fresno Kangaroo Rat Critical Habitat. Critical habitat for the Fresno kangaroo rat was designated on January 30, 1985 (50 CFR 4222–4226). This critical habitat unit does not overlap with the Project area but is located less than 2 miles south. Project activities are not expected to have any impact to Fresno kangaroo rat critical habitat; and therefore, this issue is not further addressed in this document.

Habitat Conservation Plans. There are no adopted habitat conservation plans, Natural Communities Conservation Plan, or other approved State, regional, or local habitat conservation plans in the Project area. Therefore, Project activities would not conflict with any such plans and this issue is not further addressed in this chapter.

Other Local and Regional Plans. The Fresno County General Plan and the Madera County General Plan are described under Regulatory Setting in Section 7.2.3, Regional and Local. The policies identified in these plans to protect biological resources are consistent with requirements of other State and Federal regulations. Project activities would not conflict with these policies; therefore, local and regional plans are not further addressed in Section 7.3, Environmental Consequences.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the SJRRP would be implemented, including habitat restoration, augmentation of river flows (including Restoration Flows in Reach 2B up to the existing capacity of the reach, and reintroduction of salmon. The augmentation of flows would allow riparian vegetation to naturally re-establish on river banks, especially upstream of San Mateo Avenue crossing. Without the Project in Reach 2B, however, the proposed actions in other reaches would not achieve the Settlement goals. This section describes the impacts of the No-Action Alternative. The analysis is a comparison to existing conditions, as described in Section 7.1, Environmental Setting. No mitigation is required for No-Action.

Impact WILD-1 (No-Action Alternative): ***Project Effects on Special-Status Invertebrate Species.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area. The continuation of Restoration Flows would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would be a potentially beneficial effect on valley elderberry longhorn beetles, as increases in riparian vegetation would likely increase the number of elderberry shrubs, the beetle’s host plant. As a result, there would be a **beneficial** effect on special-status invertebrate species.

Impact WILD-2 (No-Action Alternative): ***Project Effects on Special-Status Reptile and Amphibian Species.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area.

Currently, in the summer, the San Joaquin River arm of Mendota Pool extends to San Mateo Avenue, providing approximately 7 linear miles of slackwater habitat. Current management activities include drawing down Mendota Pool periodically (approximately every 2 years) during winter months for dam inspections and routing a portion of spring and early summer flood flows through Reach 2B. Although both of these activities could temporarily reduce prey base or habitat suitability for giant garter snake or western pond turtle, the margins of Mendota Pool areas near Mendota Dam and along the San Joaquin River arm are otherwise largely suitable for giant garter snake basking and foraging during most of their active period. Restoration Flows associated with the No-Action Alternative would provide flow along Reach 2B in summer months (approximately 45 cubic feet per second [cfs]) for all water year types except for critical years. This flow regime is not very different from flow through Reach 2B in recent years under Interim Flows. With the No-Action Alternative flows through Reach 2B would be limited by the existing channel capacity (additional flow would be routed through the Chowchilla Bypass), and would therefore be similar to Interim Flows.

Although changes in flow that affect water temperature and velocity in Reach 2B, particularly between Mendota Dam and San Mateo Avenue, could affect habitat suitability for giant garter snakes and western pond turtles and their prey along the river channel, the change from Interim Flows to Restoration Flows would be relatively small. These changes are not expected to affect the other special-status reptile and amphibian species (blunt-nosed leopard lizard, silvery legless lizard, San Joaquin coachwhip, coast horned lizard, and western spadefoot). The Program would implement Conservation Measure GGS-2, which includes restoration of giant garter snake habitat temporarily affected and compensation for giant garter snake habitat permanently affected (SJRRP 2011b, PEIS/R Table 2-7, page 2-65). In conclusion, there would be a **less than significant** impact to special-status reptiles and amphibians.

Impact WILD-3 (No-Action Alternative): ***Project Effects on Special-Status Bird Species.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area. The continuation of Restoration Flows would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide greater foraging and nesting habitat for Swainson’s hawks, white-tailed kites, and short-eared owls. No special-status birds are expected to be adversely affected. As a result, there would be a **beneficial** effect on special-status birds.

Impact WILD-4 (No-Action Alternative): ***Project Effects on Special-Status Mammal Species.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area. The continuation of Restoration Flows would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide greater foraging and roosting habitat for western red bats and more foraging habitat for western mastiff bats. There would be no adverse effects to American badgers. As a result, there would be a **beneficial** effect on special-status mammals.

Impact WILD-5 (No-Action Alternative): ***Project Effects on Wildlife Movement Corridors.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area. The continuation of Restoration Flows would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide cover and forage for animals moving along the river course. It would also provide more habitat for migratory bird species that may use the area as a stopping point for seasonal migrations. As a result, there would be a **beneficial** effect on wildlife movement.

Impact WILD-6 (No-Action Alternative): ***Long-term Habitat Improvement in Reach 2B.*** Under the No-Action Alternative, Restoration Flows would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide for long-term opportunities for habitat improvement in Reach 2B. As a result, there would be a **beneficial** effect on wildlife habitat.

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities including a Compact Bypass channel, a new levee system with a narrow floodplain encompassing the river channel, and the South Canal. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, the South Canal bifurcation structure and fish passage facility, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure of the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

This alternative includes passive riparian habitat restoration and agricultural practices in the floodplain. It is assumed that over time wetland communities and a dense riparian scrubland would develop along the main channel and river banks, respectively. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur.

Table 7-5 summarizes potential habitat impacts by acreage for all vertebrate species with the potential to occur in the Project area. These acreages represent the worst-case scenario where all existing floodplain areas are assumed to be impacted. “Floodplain” primarily refers to the floodplain of the San Joaquin River and the acreage impacted under this category may be disturbed up to 3 years following construction, but is expected to eventually return to habitat. “Infrastructure” generally refers to area permanently converted to structures, levees, or roads. The borrow acreages refer to the maximum amount of habitat for each species that could be disturbed to take fill materials for levees. “Other” refers to construction staging areas, temporary access roads and other construction-related disturbances. Areas temporarily disturbed during construction would be restored to their previous contours, if feasible, and then seeded with a native vegetation seed mixture to prevent soil erosion. Some areas, such as borrow areas, may not be feasible to restore previous contours, but these areas would be smoothed and seeded (see Section 2.2.4).

Table 7-5.
Species Habitat Potentially Affected by Alternative A

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Reptiles and Amphibians						
Actinemys marmorata	western pond turtle	Aquatic	122	22	47	21
		upland	196	21	46	12
Anniella pulchra pulchra	silvery legless lizard	Habitat	322	54	204	32
Gambelia sila	blunt-nosed leopard lizard	Habitat	3	13	0	0
Masticophis flagellum ruddocki	San Joaquin coachwhip	Habitat	73	26	200	3
Phrynosoma blainvillii	coast horned lizard	Habitat	144	40	201	5
Spea hammondii	western spadefoot	Breeding Habitat	0	0.6	0	0
Thamnophis gigas	giant garter snake	Aquatic	122	22	47	21
		Upland	196	21	46	12
Birds						
Agelaius tricolor	tricolored blackbird	Foraging	247	117	≤350	9
		Nesting	96	21	95	3
Anser albifrons elgasi	greater white-fronted goose	Foraging	217	26	47	21
Asio flammeus	short-eared owl	Foraging and Nesting	74	31	200	3
		Foraging	174	103	≤350	6
Athene cunicularia	burrowing owl	Foraging and Nesting	74	31	200	3
		Foraging	174	103	≤350	6
Aythya americana	Redhead	Foraging	185	21	43	19
		Nesting	32	6	3	2
Buteo swainsoni	Swainson's hawk	Foraging	313	136	≤350	10
		Nesting	249	36	4	29
Charadrius montanus	mountain plover	Foraging	249	134	≤350	9

**Table 7-5.
Species Habitat Potentially Affected by Alternative A**

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Circus cyaneus	northern harrier	Foraging	176	108	≤350	6
		Nesting	169	35	203	6
Elanus leucurus	white-tailed kite	Foraging	343	138	≤350	12
		Nesting	249	36	4	29
Grus canadensis canadensis	lesser sandhill crane	Foraging	343	138	≤350	12
Grus canadensis tabida	greater sandhill crane	Foraging	343	138	≤350	12
Lanius ludovicianus	loggerhead shrike	Foraging	247	129	≤350	9
		Foraging and Nesting	2	5	0	0
Numenius americanus	long-billed curlew	Foraging	249	134	≤350	9
Pelecanus erythrorhynchos	American white pelican	Foraging	217	26	47	21
Xanthocephalus xanthocephalus	yellow-headed blackbird	Foraging	247	129	≤350	9
		Nesting	96	9	3	3
Mammals						
Dipodomys nitratoides exilis	Fresno kangaroo rat	Habitat	3	13	0	0
Eumops perotis californicus	Western mastiff bat	Foraging	405	155	≤350	29
Lasiurus blossevillii	Western red bat	Roosting and Foraging	885	142	≤350	71
Taxidea taxus	American badger	Habitat	73	26	200	3

Notes:
Floodplain = floodplain of the San Joaquin River (passive restoration and agricultural activities)
Infrastructure = structures, levees, or roads
Borrow = maximum amount disturbed to take fill materials for levees (reseeded)
Other = construction staging areas, temporary access roads, and other construction-related disturbances (reseeded)

Impact WILD-1 (Alternative A): ***Project Effects on Special-Status Invertebrate Species.*** The only special-status invertebrate currently believed to have potential to occur in the Project area is valley elderberry longhorn beetle. Since earlier Project documents were published, including the *Mendota Pool Bypass and Reach 2B Improvements Project Technical Memorandum on Environmental Field Survey Results* (SJRRP 2011a), USFWS has published range information for the valley elderberry longhorn beetle that excludes the Project location (USFWS 2015). The range as currently mapped by USFWS includes portions of the Sacramento and San Joaquin valleys but terminates northwest of Firebaugh, approximately 9 miles northwest of the Project area. Based on this information, valley elderberry longhorn beetle is no longer expected to occur in the Project area.

Compared to the No-Action Alternative, Alternative A could affect valley elderberry longhorn beetle if present in the Project area, due to construction-related activities and habitat modifications. Elderberry shrubs were mapped at a number of locations within the Alternative A footprint in the riparian corridor along the river channel and in elderberry savannah habitat (SJRRP 2011a). In addition to the 2011 protocol survey, elderberry shrub locations have been documented through field surveys conducted for the SJRRP (ICF 2014), and incidental observations made while conducting other Project activities (Figure 3-4). A total of 630 elderberry shrubs have been mapped within the footprint of Alternative A. Levee construction, removal, and protection; floodplain grading; and the placement of other Project infrastructure (e.g., South Canal bifurcation structure) would result in long-term habitat conversion or modification, including damage or removal of elderberry shrubs and modifications to riparian scrub and elderberry savannah habitats. Conservation Measure VELB-1 includes pre-construction surveys for elderberry shrubs and avoidance of elderberry shrubs found in the Project area, to the extent feasible (Table 2-8).

Long-term effects of Alternative A include passive riparian habitat restoration in the floodplain and periodic maintenance activities such as removal of instream sediments near water control structures. The continuation of Restoration Flows in the expanded floodplain would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This could have a beneficial effect on valley elderberry longhorn beetles if present in the Project area, as increases in riparian vegetation would likely increase the number of elderberry shrubs, the beetle’s host plant.

When comparing Alternative A to existing conditions, impacts to special-status invertebrate species would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Because the valley elderberry longhorn beetle is no longer expected to occur in the Project area, implementation of Project conservation measures will reduce impacts to elderberry shrubs, and because the completed Project would provide habitat for elderberry shrubs, Project impacts are considered **less than significant**.

Impact WILD-2 (Alternative A): ***Project Effects on Special-Status Reptile and Amphibian Species.*** Compared to the No-Action Alternative, Alternative A could affect special-status reptile and amphibian species (i.e., blunt-nosed leopard lizard, giant garter snake, western pond turtle, silvery legless lizard, San Joaquin coachwhip, coast horned lizard, and western spadefoot) due to activities such as vehicle traffic, the temporary use of land for staging and access areas, noise, light, vibration, and other construction-related activities (e.g., grubbing, grading, tree removal, excavation, and driving off-road) that could alter reptile and amphibian habitat and directly affect special-status reptile and amphibian species. These direct effects on special-status reptiles and amphibians could include mortality, injury, or harassment of adults, eggs, or juveniles as a result of construction activities in suitable habitat. Construction may also result in the destruction or degradation of habitat and the loss of nesting areas, burrows, or other refugia. Mortality, injury, or harassment may also occur if these species become trapped in open, excavated areas. Construction activities could result in temporary shifts in foraging patterns or territories and increased predation as a result of increased noise, light, infrastructure, and ground vibrations where suitable habitat is present.

Indirect effects on reptiles and amphibians may include the inadvertent introduction of non-native invasive (noxious) weeds, which can reduce habitat suitability (see Chapter 6.0, "Biological Resources – Vegetation"). However, Conservation Measure INV-1 includes measures to monitor, control, and where possible eradicate invasive plant infestations during construction activities (see Table 2-8). Soil compaction, cutting, and the placement of fill in suitable habitat may indirectly affect special-status reptiles and amphibians by temporarily prohibiting burrowing, or by changing the frequency of vegetative cover. Construction activities may attract opportunistic predators (e.g., ravens, feral cats, and raccoons) that may feed on special-status reptiles and amphibians.

Direct effects include the conversion of one habitat type to another or to Project infrastructure. This could result in the loss of individual special-status reptiles and amphibians and their habitats within the limits of disturbance. However, much of the affected habitat within the floodplain would be allowed to return to natural habitat following Project construction disturbance, and these areas would continue to provide suitable habitat for special-status reptiles and amphibians (Table 7-5). Some areas with habitat for special-status reptiles and amphibians would be affected during construction for construction staging or construction access. Borrow areas that provide suitable habitat for special-status reptiles and amphibians could be affected. Project infrastructure would result in a small amount of loss or modification of wetland (e.g., Mendota Pool Dike) and upland habitats that may support special-status reptile and amphibian species.

Implementation of Alternative A would directly affect a small amount of habitat identified as potentially suitable for blunt-nosed leopard lizard (Table 7-5). A small portion of the area affected would become natural habitat again upon Project completion, and a larger portion would be converted to Project infrastructure or levees. Construction could result in destruction of rodent burrows used by lizards for shelter. DFW lists the blunt-nosed leopard lizard as a fully-protected species. Direct take (killing or injuring) of individual lizards is prohibited. To comply with this level of protection, Conservation Measures BNLL-1 includes protocol-level surveys in potentially suitable habitat prior to ground disturbance, in coordination with USFWS and DFW (Table 2-8). If blunt-nosed leopard lizard were detected, consultation would be reinitiated with the USFWS as described in Conservation Measure BNLL-1 and additional avoidance, mitigation, and compensation measures, including measures that would avoid direct take of this species, would be developed in coordination with USFWS and DFW and implemented before ground-disturbing activities.

The primary habitat of one of 13 remnant populations of giant garter snake is Mendota Wildlife Area, roughly 3 miles south of the Project area and hydraulically connected to

Mendota Pool via Fresno Slough (SJRRP 2011a). Implementation of Alternative A would directly affect open water, upland, and emergent wetland habitat potentially used by giant garter snake (Table 7-5). Most of the habitat affected would be left to passively return to natural habitat upon Project completion. Some of the habitat would be affected by construction staging or access, and some of the habitat would be converted to Project infrastructure and levees. Although the exact location of the up to 350 acres of borrow has not been identified, potential borrow areas include some giant garter snake habitat; these areas would be avoided when feasible. Conservation Measure GGS-1 includes preconstruction surveys, avoidance of suitable giant garter snake habitat, restriction of ground disturbance in suitable habitat to the active season for giant garter snakes or other measures to avoid take if work must occur during the inactive season, and other measures to avoid and minimize harming giant garter snakes during construction (see Table 2-8). Conservation Measure GGS-2 includes restoration of giant garter snake habitat temporarily affected during construction.

Although construction may not directly affect certain areas of suitable habitat for giant garter snake, these areas may be indirectly affected by hydrologic changes in the San Joaquin River that would result from Project implementation. In the No-Action Alternative, much of the aquatic habitat in the Project area is maintained wet through much of the giant garter snake's summer active period by artificial impoundment of water behind Mendota Dam. The San Joaquin River arm of Mendota Pool extends to San Mateo Avenue in summer months, providing approximately 7 linear miles of slackwater habitat. The habitat in and near Mendota Pool is highly suitable for giant garter snake. Further upstream in the San Joaquin River arm of the Mendota Pool, habitat transitions and becomes less suitable for giant garter snake. There is less emergent vegetation and stream banks are sandier and support vegetation more typical of riparian scrub and forest than emergent wetland. Current management activities include drawing down Mendota Pool periodically during winter months and routing a portion of spring and early summer flood flows through Reach 2B; these management activities will continue under Alternative A. Although both of these activities could temporarily reduce prey base or habitat suitability for giant garter snake or western pond turtle, the margins of Mendota Pool areas near Mendota Dam and less so along the San Joaquin River arm are otherwise largely suitable for giant garter snake basking and foraging during most of their active period.

Project implementation would largely remove the San Joaquin arm of Mendota Pool. Alternative A would limit its extent to the Mendota Pool Dike; therefore, upstream aquatic conditions during the giant garter snake active period may vary over time and be a mix of slackwater, flowing water, and dry channel, which would likely be less suitable for giant garter snake than conditions currently found in Mendota Pool. Under Alternative A, the linear extent of the near-permanent slackwater habitat in the San Joaquin arm of Mendota Pool would be reduced to 0.6 mile. Although giant garter snakes would find suitable habitat in the Fresno Slough arm of Mendota Pool and may find some suitable habitat in the reconfigured river channel, compared to the No-Action Alternative, this would likely result in a reduction in potentially suitable habitat for giant garter snake. This could similarly affect western pond turtle, an aquatic turtle that is expected to prefer similar habitats in the Project area as giant garter snake. However, Conservation Measure

GGS-2 includes compensation for the long-term loss of giant garter snake habitat at a ratio and in a manner determined through consultation with USFWS and DFW including specific measures such as the restoration and creation of suitable habitat (Table 2-8). Impacts to western pond turtle during construction would be minimized through implementation of Conservation Measure WPT-1.

Long-term effects of Alternative A include passive restoration in the expanded floodplain and periodic maintenance activities such as removal of instream sediments near water control structures. Floodplain habitat would include floodplain benches and floodplain channels inundated under high flow conditions (i.e., high flow channels) which would have lower velocities than the main channel (see Figure 2-3). This could provide some suitable habitat for giant garter snakes, western pond turtles, and their prey near the main channel of the river. Changes in flow regime that affect water temperature and velocity are not expected to affect the other special-status reptile and amphibian species (blunt-nosed leopard lizard, silvery legless lizard, San Joaquin coachwhip, coast horned lizard, and western spadefoot). However, these special-status reptiles and amphibians could benefit from the conversion of agricultural lands to restored natural habitat.

When comparing Alternative A to existing conditions, impacts to special-status reptile and amphibian species would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Temporary impacts during construction activities would vary spatially and occur intermittently within the overall construction timeframe for the entire Project, and most of the habitat for special-status reptiles and amphibians affected would either be restored or remain as natural habitats at Project completion. Implementation of conservation measures would control or eradicate non-native invasive plants, which can negatively impact special-status reptiles and amphibians. Conservation measures to avoid and minimize impacts, and/or to compensate for impacts, have been incorporated into the Project for blunt-nosed leopard lizard, giant garter snake, and western pond turtle. Additionally, avoidance, minimization, and compensation measures incorporated into the Project for giant garter snake would also benefit western pond turtle. Therefore, impacts to special-status reptile and amphibian species are considered **less than significant**.

Impact WILD-3 (Alternative A): ***Project Effects on Special-Status Bird Species.*** Compared to the No-Action Alternative, Alternative A could affect special-status bird species (i.e., Swainson’s hawk, white-tailed kite, greater sandhill crane, tricolored blackbird, greater white-fronted goose, short–eared owl, burrowing owl, redhead, mountain plover, northern harrier, lesser sandhill crane, loggerhead shrike, long-billed curlew, American white pelican, and yellow-headed blackbird) due to construction-related activities and habitat modifications. Direct effects of construction-related activities to special-status bird species include the potential mortality, injury or harassment of adults, juveniles, and nests due to construction vehicle traffic; the temporary use of land for staging and access areas; noise, light, and vibration from construction activities; and other site-preparation activities (i.e., grubbing, grading, tree removal, excavation, and driving off-road). Levee construction, removal, and protection, floodplain grading, and the placement of other Project infrastructure (i.e., South Canal bifurcation structure) would result in long-term conversion or modification of habitat that may support special-status bird species after construction is complete.

Almost all native bird species are protected broadly under the Migratory Bird Treaty Act. To avoid and minimize adverse effects to native birds, Conservation Measure MBTA-1 (Table 2-8) will restrict some Project activities to the non-breeding season, to the extent feasible, or provide biological monitoring to ensure activities do not interrupt breeding. Conservation Measure MBTA-1 will also establish an Avian Protection Plan to further minimize and/or avoid adverse effects to native bird species. Direct effects on breeding raptor species would be avoided or minimized by implementation of Conservation Measures RAPTOR-1 and RAPTOR-2 (Table 2-8). These measures would restrict some construction activities to the non-breeding season to protect nests, to the extent feasible, or provide biological monitoring to protect nests. If nests are found, a no-disturbance buffer would be established until birds have fledged. If any native trees suitable for raptor nesting are removed during Project activities, they would be replaced. Effects to least Bell's vireo would be avoided or minimized by Conservation Measure RNB-1. These measures require preconstruction surveys when riparian nesting birds are anticipated in the Project area, and construction avoidance and minimization measures. Effects to nesting tricolored blackbirds would be avoided or minimized by Conservation Measure TRI-1, and effects to nesting swallows would be avoided or minimized by Conservation Measure SWA-1. These measures require avoidance and biological monitoring of tricolored blackbird and swallow nests.

Indirect effects of construction activities on birds may include creation of conditions in active work areas that attract opportunistic predators such as raccoons and domestic cats. Changes to vegetation type and structure, including the introduction of non-native invasive plant species, may decrease habitat suitability for foraging, nesting, or cover. Conservation Measure INV-1 (Table 2-8) would lessen the effects of invasive plant species by controlling and eradicating invasive plants where possible.

Implementation of Alternative A is likely to result in a combination of adverse effects as a result of construction, followed by long-term beneficial effects to special-status bird species. The placement of structures and levees would affect only a small proportion of habitat within the Project footprint (Table 7-5). Areas used for construction staging or access would be revegetated or returned to pre-project conditions; borrow areas would be disturbed during construction and revegetated at lower elevations (see Section 2.2.4). The analysis of effects to habitat for special-status bird species is based on species' association with specific habitats, but many of these species are capable of occurring across a variety of habitat types.

Implementation of Alternative A would affect habitat suitable for Swainson's hawk foraging and nesting (Table 7-5). To reduce the adverse effects of construction to Swainson's hawks, Conservation Measure SWH-1 requires preconstruction surveys for nesting Swainson's hawks. If nests are found, a no-disturbance buffer would be established until the nest is inactive, when possible, or biological monitoring would be provided to ensure construction does not interrupt breeding activity. Most of the areas affected by Project activities would be passively returned to natural habitat, but a smaller portion would be converted to Project infrastructure or levees. Removal of foraging habitat or nesting trees will be compensated by establishing habitat suitable for foraging and nesting trees suitable for Swainson's hawks (Conservation Measure SWH-2, Table 2-8).

Burrowing owls require special consideration as, unlike other bird species addressed in this document, they live in underground burrows, making them particularly susceptible to ground disturbance, digging, and excavating. To protect burrowing owls and minimize effects, Conservation Measures BRO-1 and BRO-2 will be implemented (Table 2-8). These measures would decrease potential for adverse effects by avoiding work around active burrows. No-disturbance zones would be established around occupied burrows. Burrowing owls in the Project area would be passively relocated if they are not breeding. If occupied burrows are destroyed during construction, burrows outside of the active Project area would be enhanced or created to provide habitat for these birds.

Long-term effects of Alternative A include passive riparian habitat restoration in the floodplain and periodic maintenance activities such as removal of instream sediments near water control structures. The continuation of Restoration Flows in the expanded floodplain would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide greater foraging and/or nesting habitat for Swainson's hawks, white-tailed kites, and short-eared owls.

When comparing Alternative A to existing conditions, impacts to special-status bird species would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Implementation of Alternative A should eventually result in a long-term net increase in the type and diversity of aquatic and riparian microhabitats associated with the river system. Project construction would require significant modifications to the existing levees, which would result in the loss of riparian nesting and foraging habitat. These impacts would be mostly temporary, and most of the habitat suitable for special-status birds would be allowed to return to riparian floodplain habitats or restored at Project completion. Avoidance, minimization, and conservation measures incorporated into the Project are broadly protective, reducing impacts to nesting activity for essentially all native birds. Additional measures would reduce impacts to raptors, with special attention to Swainson's hawk and burrowing owl. Loss of Swainson's hawk nesting and foraging habitat would be compensated. With the inclusion of these conservation measures, project impacts to special-status bird species are considered **less than significant.**

Impact WILD-4 (Alternative A): ***Project Effects on Special-Status Mammal Species.*** Compared to the No-Action Alternative, Alternative A could affect special-status mammal species (Fresno kangaroo rat, western mastiff bat, western red bat, and American badger) due to construction-related activities and habitat modifications. Construction-related activities, including construction vehicle traffic; temporary use of land for staging and access areas; noise, light, and vibration from construction activities; and other site-preparation activities (i.e., grubbing, grading, tree removal, excavation, and driving off-road) in suitable habitat for special-status mammals could result in mortality, injury, or harassment of special-status mammal species. Levee construction, removal, and protection, and the placement of other Project infrastructure (i.e., South Canal bifurcation structure) would result in long-term habitat conversion or modification of habitats that may support these mammal species after construction is complete.

Construction activities may attract opportunistic predators that may prey on special-status mammals. Lighted construction areas could disorient species and disrupt nocturnal foraging activities. Ground disturbance could lead to the temporary loss of foraging and burrowing habitat. Most of the adverse effects associated with construction are considered temporary. For most of the special-status mammal species, much of the affected habitat would be passively returned to natural conditions following Project construction (Table 7-5). Borrow areas, staging areas and temporary access roads would be stabilized (e.g., revegetated) or returned to pre-project conditions and function as habitat following implementation of Alternative A.

Potential construction effects on western red bats and western mastiff bats would be a temporary loss or change of foraging and roosting habitat from disturbance. In order to minimize effects to special-status bats, avoidance and minimization measures are incorporated into the Project (Table 2-8). Conservation Measure BAT-1 includes surveys for locating bat roosts prior to construction activities and excluding bats from active work zones during appropriate seasons. Any roosts removed or damaged during construction will be replaced with agency-approved and suitable bat boxes (Conservation Measure BAT-2).

Potential Fresno kangaroo rat habitat quality and quantity would diminish with implementation of Alternative A due to construction activities, though the amount of potential habitat that would be affected by Project activities is small (Table 7-5). Three areas with potentially suitable habitat on the eastern end of Reach 2B of the San Joaquin River were surveyed for Fresno kangaroo rat and none were detected (SJRRP 2011a). Access for surveys was not available in all areas of potentially suitable habitat on the south side of the river and there is a low potential for the species to occur there. If present, indirect effects on Fresno kangaroo rat from temporary habitat conversion could include shifts in foraging patterns or territories, increased predation, and decreased reproductive success. Alteration and compaction of soils would render portions of the potentially suitable habitat less suitable for Fresno kangaroo rat burrowing. To minimize the potential adverse effects of construction focused live trapping surveys would be conducted by qualified biologists using approved methodologies in areas identified as suitable habitat prior to construction. If detected, consultation would be reinitiated with the USFWS as described in Conservation Measure FKR-1 and additional avoidance, mitigation, and compensation measures would be developed in coordination with USFWS and DFW and implemented before ground-disturbing activities. Construction activities in occupied habitat would be timed to occur during the non-breeding season (FKR-1, Table 2-8).

Although there is a low potential for San Joaquin kit fox to occur in the Project area, Conservation Measure SJKF-1 will be implemented to identify potential dens, avoid occupied dens near construction areas, and if dens are located within the proposed work area, time construction activities to avoid the normal breeding season.

Long-term effects of Alternative A include passive riparian habitat restoration in the floodplain and periodic maintenance activities such as removal of instream sediments near water control structures. The continuation of Restoration Flows in the expanded floodplain would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide greater foraging and roosting habitat for western red bats and more foraging habitat for western mastiff bats.

When comparing Alternative A to existing conditions, impacts to special-status mammals would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Most of the project impacts would be limited to the duration of construction. Construction impacts would be temporary and would occur intermittently at discrete locations within the overall construction timeframe for the entire Project. Post-project conditions would passively return to natural habitats in much of the disturbed areas. Conservation measures that will be implemented for Alternative A are designed to minimize and avoid adverse impacts to special-status mammal species. With the inclusion of these measures, impacts of Alternative A to special-status mammals are considered **less than significant**.

Impact WILD-5 (Alternative A): ***Project Effects on Wildlife Movement Corridors.*** Compared to the No-Action Alternative, Alternative A could affect wildlife movement along migration corridors. Wildlife movement refers to localized, small distance movements made by animals within a home range; seasonal shifts for the purposes of locating food and water or breeding territory; larger dispersal movement of an individual between suitable habitats; and true trans-continental migrations. Many species, including most invertebrates, reptiles and amphibians, and small mammals, are restricted to smaller distance migrations. A number of bird species (including Swainson's hawk, greater sandhill crane, greater white-fronted goose, redhead, mountain plover, northern harrier, lesser sandhill crane, loggerhead shrike, long-billed curlew, and American white pelican) make longer, seasonal migrations.

Construction activities such as vehicle traffic, the temporary use of land for staging and access areas, noise, light, vibration, and any other construction-related activities (e.g., grubbing, grading, tree removal, excavation, and driving off-road) may deter animals from using the area during migration. Construction may also result in the temporary destruction or degradation of habitat and the temporary loss of vegetated movement corridors. Direct mortality, injury, or harassment may also occur to species using the area for dispersal or migration. Construction activities may attract opportunistic predators (e.g., ravens, feral cats, and raccoons) that may feed on migrating species. Long-term construction effects include the conversion of small portions of a migration corridor to Project-related infrastructure, but also an overall expansion of habitat suitable for wildlife movement upon Project completion.

Only discrete subsections of the Project area would be under construction at any given time during the overall construction period, thereby reducing the severity of adverse effects associated with the creation of movement barriers. Wildlife would be able to move unobstructed through most of the Project area, particularly at night, throughout the duration of Project activities. Disturbance of riparian vegetation will be avoided to the greatest extent practicable, as required by Conservation Measure EFH-1. Implementing Conservation Measure RHSNC-1 (Table 2-8) would minimize and avoid losses of riparian habitat. Implementing RHSNC-2 would compensate for any losses of riparian habitat or other sensitive natural communities.

Long-term effects of Alternative A include passive riparian habitat restoration in the floodplain and periodic maintenance activities such as removal of instream sediments near water control structures. The continuation of Restoration Flows in the expanded floodplain would allow riparian vegetation to establish along previously bare banks of the San Joaquin River. This would provide cover and forage for animals moving along the river course. It would also provide more habitat for migratory bird species that may use the area as a stopping point for seasonal migrations. Post-project conditions would generally facilitate movement and provide habitat for many special-status species, including Swainson's hawk, white-tailed kite, tricolored blackbird, yellow-headed blackbird, and western red bat.

When comparing Alternative A to existing conditions, impacts to movement corridors would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Most of these impacts would be temporary and would occur intermittently within the overall construction timeframe for the entire Project. Most of the Project impacts would be limited to the duration of construction. Post-project conditions would return natural habitats to much of the disturbed areas and are expected to increase riparian vegetation, potentially improving conditions for migratory species. Impacts of Alternative A to movement corridors are considered **less than significant.**

Impact WILD-6 (Alternative A): ***Long-term Habitat Improvement in Reach 2B.*** Compared to the No-Action Alternative, Restoration Flows in Reach 2B would be conveyed through an expanded floodplain. Over time wetland communities would develop within the main channel and a dense riparian scrubland would develop along the main river channel banks. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, agricultural practices (e.g., annual crops, pasture, or floodplain-compatible permanent crops) would occur.

Passive riparian habitat restoration of the San Joaquin River would improve native floodplain and in-channel habitats, which would likely benefit native and potentially special-status species such as Swainson's hawk (*Buteo swainsoni*) and greater sandhill crane (*Grus canadensis tabida*). Benefits to native species would be realized through the re-introduction of perennial base flows as well as seasonal high flows in the river, which in turn would promote the establishment of riparian vegetation. Well-established native plant communities in the floodplain would support rich and diverse native flora, potentially including special-status plant species, and would provide foraging habitat and shelter for native wildlife species.

Alternative A supports the following wildlife habitat improvements:

- Restoring river-floodplain connectivity and longitudinal connectivity of riparian vegetation near the channel (without major breaks in the distribution of woody vegetation except where natural conditions prevent establishment of native trees or shrubs) that can provide cover and habitat for a variety of wildlife species.
- Creating or maintaining a combination of diverse habitats required by select wildlife species, such as species that depend on occurrence of aquatic, wetland or riparian, and upland habitats to meet various life stage requirements (e.g., western pond turtle, Swainson's hawk).
- Enhancing landscape connectivity between the river corridor and adjacent areas of ecological significance (e.g., wildlife refuges and other protected lands, biodiversity "hotspots," adjacent sloughs or tributary channels with existing riparian habitat, wildlife movement corridors, and natural preserves such as the Mendota Wildlife Area).

When comparing Alternative A to existing conditions, effects on long-term opportunities for habitat improvement in Reach 2B would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). According to habitat restoration estimates, Alternative A could provide up to 1,330 acres of wildlife habitat and up to 1,070 acres of special-status species habitat (areas not mutually exclusive) (SJRRP 2012, Attachment A). For many of these habitat types, this represents a 2- to 5-fold increase in habitat as compared to existing conditions. In general, implementation of Alternative A would cause a **beneficial** effect on wildlife habitat.

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features including a Compact Bypass channel, a new levee system with a wide, consensus-based floodplain encompassing the river channel, the Mendota Pool Control Structure, and the Compact Bypass Control Structure with fish passage facility. Other key features include construction of a fish passage facility at the San Joaquin River control structure of Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass Control Structure), and removal of the San Mateo Avenue crossing. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

This alternative includes a mixture of active and passive riparian and floodplain habitat restoration and compatible agricultural activities in the floodplain. It is assumed that wetland communities and a dense riparian scrubland would develop along the main channel and river banks, respectively, and bands of other habitat types (wetland, scrub, grassland, and forest) would develop at higher elevations along the channel corridor. Plantings that are wetland species or borderline wetland species would be irrigated and managed as necessary during the establishment period.

Table 7-6 summarizes maximum habitat impacts by acreage for all vertebrate species with the potential to occur in the Project area. These acreages represent the worst-case scenario where all existing floodplain areas are assumed to be impacted.

Table 7-6.
Species Habitat Potentially Affected by Alternative B

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Reptiles and Amphibians						
Actinemys marmorata	western pond turtle	Aquatic	123	14	0	6
		Upland	201	19	0	1
Anniella pulchra pulchra	silvery legless lizard	Habitat	344	65	131	22
Gambelia sila	blunt-nosed leopard lizard	Habitat	5	20	0	0
Masticophis flagellum ruddocki	San Joaquin coachwhip	Habitat	75	22	131	7
Phrynosoma blainvillii	coast horned lizard	Habitat	156	42	131	8
Spea hammondii	western spadefoot	Breeding Habitat	0.4	0.7	0	0
Thamnophis gigas	giant garter snake	Aquatic	123	14	0	6
		Upland	201	19	0	1
Birds						
Agelaius tricolor	tricolored blackbird	Foraging	259	51	≤350	49
		Nesting	94	9	0	1
Anser albifrons elgasi	greater white-fronted goose	Foraging	218	16	0	7
Asio flammeus	short-eared owl	Foraging and Nesting	78	30	131	7
		Foraging	185	31	287	43
Athene cunicularia	burrowing owl	Foraging and Nesting	78	30	131	7
		Foraging	185	31	287	43
Aythya americana	redhead	Foraging	188	11	0	6
		Nesting	30	5	0	1
Buteo swainsoni	Swainson's hawk	Foraging	326	61	≤350	48
		Nesting	270	43	0	15
Charadrius montanus	mountain plover	Foraging	263	61	≤350	49
Circus cyaneus	northern harrier	Foraging	188	39	287	43
		Nesting	168	29	131	8
Elanus leucurus	white-tailed kite	Foraging	353	60	≤350	50
		Nesting	270	43	0	15

Table 7-6.
Species Habitat Potentially Affected by Alternative B

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Grus canadensis canadensis	lesser sandhill crane	Foraging	353	60	≤350	50
Grus canadensis tabida	greater sandhill crane	Foraging	353	60	≤350	50
Lanius ludovicianus	loggerhead shrike	Foraging	259	53	≤350	49
		Foraging and Nesting	3	8	0	0
Numenius americanus	long-billed curlew	Foraging	263	61	≤350	49
Pelecanus erythrorhynchos	American white pelican	Foraging	218	16	0	7
Xanthocephalus xanthocephalus	yellow-headed blackbird	Foraging	259	53	≤350	49
		Nesting	94	7	0	1
Mammals						
Dipodomys nitratoides exilis	Fresno kangaroo rat	Habitat	5	20	0	0
Eumops perotis californicus	Western mastiff bat	Foraging	434	95	≤350	65
Lasiurus blossevillii	Western red bat	Roosting and Foraging	1,041	213	0	23
Taxidea taxus	American badger	Habitat	75	22	131	7

Notes:
Floodplain = floodplain of the San Joaquin River (mixture of active and passive restoration and agricultural activities)
Infrastructure = structures, levees, or roads
Borrow = maximum amount disturbed to take fill materials for levees (reseeded)
Other = construction staging areas, temporary access roads, and other construction-related disturbances (reseeded)

Impact WILD-1 (Alternative B): ***Project Effects on Special-Status Invertebrate Species.*** Compared to the No-Action Alternative, Alternative B could affect special-status invertebrates. Construction-related effects on special-status invertebrate species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative B would use the Mendota Pool Control Structure to convey water from the San Joaquin River to Mendota Pool (and excludes the South Canal and associated levees). Differences would result in effects on more elderberry shrubs, in comparison to Alternative A. Up to 649 shrubs are potentially affected by Alternative B, 19 more than Alternative A. Conservation Measures VELB-1 includes pre-construction surveys for elderberry shrubs and avoidance of elderberry shrubs where feasible (Table 2-

8). Portions of the future floodplain areas would be allowed to return to natural habitats after Project construction is complete, which would provide suitable habitat for elderberry shrubs after construction is complete, especially along the main river channel banks where many of the elderberry shrubs occur now. Alternative B also features a wide, consensus-based floodplain and a mixture of active and passive restoration and floodplain compatible agricultural activities. These features would result in more riparian habitat over the long-term and presumably more valley elderberry longhorn beetle habitat than Alternative A.

Construction activity under Alternative B is expected to take 157 months; therefore, adverse effects of construction would occur over an approximately 2 years longer period as compared to Alternative A.

When comparing Alternative B to existing conditions, impacts to special-status invertebrates would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). Because the valley elderberry longhorn beetle is no longer expected to occur in the Project area, these impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and because the completed Project would provide habitat for elderberry shrubs, these impacts are considered **less than significant**.

Impact WILD-2 (Alternative B): ***Project Effects on Special-Status Reptile and Amphibian Species.*** Compared to the No-Action Alternative, Alternative B could affect special-status reptile and amphibian species. Construction-related effects on special-status reptile and amphibian species would generally be the same as those described for Alternative A (see Impact WILD-2 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative B would create a wide, consensus-based floodplain. This change would result in adverse effects on slightly less habitat for most special-status reptiles compared to Alternative A (see Table 7-6). Alternative B would affect more potential habitat for both blunt-nosed leopard lizard and western spadefoot than Alternative A. A larger portion of the habitat affected would be converted to Project infrastructure than under Alternative A, potentially resulting in a larger long-term effect on those species (if present). All adverse effects to blunt-nosed leopard lizard would be avoided and/or mitigated with implementation of the Conservation Measure BNLL-1 (Table 2-8). As a fully-protected species, direct take of blunt-nosed leopard lizards would be prohibited.

Alternative B would affect less potential habitat for giant garter snake than Alternative A, and more of the potential habitat affected under Alternative B would remain as or be restored to natural habitats upon Project completion, resulting in a potentially reduced long-term effect on this species in comparison to Alternative A. Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status reptiles (see Impact WILD-2 [Alternative A] and Table 2-8).

The Mendota Pool Control Structure (Alternative B) would be in the same location as the Mendota Pool Dike (Alternative A). Therefore, both of these alternatives would provide equivalent amounts of slackwater habitat for giant garter snake in the San Joaquin River arm of Mendota Pool (see Impact WILD-2 [Alternative A]) following Project completion.

When comparing Alternative B to existing conditions, impacts to special-status reptiles and amphibians would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). Because these impacts would occur intermittently within the overall construction timeframe, and conservation measures are in place to reduce, minimize, and compensate for impacts, they are considered **less than significant**.

Impact WILD-3 (Alternative B): ***Project Effects on Special-Status Bird Species.*** Compared to the No-Action Alternative, Alternative B could affect special-status bird species. Construction-related effects on special-status bird species would generally be the same as those described for Alternative A (see Impact WILD-3 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative B would create a wide, consensus-based floodplain. This change would result in adverse effects on slightly more habitat for most special-status birds than Alternative A (see Table 7-6). However, most of this habitat would remain as or be restored to native habitats upon Project completion. Similar to Alternative A, measures would be implemented to minimize adverse effects to special-status birds (see Impact WILD-3 [Alternative A] and Table 2-8).

The wide floodplain featured in Alternative B may provide more foraging and/or nesting habitat (compared to the narrow floodplain) for a number of species, including the Northern harrier, greater sandhill crane, Swainson's hawk, long-billed curlew, and short-eared owl, compared to both Alternative A and the No-Action Alternative. Under Alternative B, the floodplain and associated riparian habitat would include active restoration areas, whereas under Alternative A, passive restoration would depend on the availability of the existing seed bank and seed sources. Following construction of Alternative B Project components, wetland, floodplain, and riparian areas in the active restoration portion would be planted and irrigated until vegetation was established (see Chapter 2.0, "Description of Alternatives"). This could result in more rapid development of riparian habitat important to birds following construction.

When comparing Alternative B to existing conditions, impacts to special-status birds would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). Because the majority of these impacts would be temporary and would occur intermittently within the overall construction timeframe, because conservation measures are in place to reduce and minimize impacts, and because active restoration of riparian habitats would occur, they are considered **less than significant**.

Impact WILD-4 (Alternative B): ***Project Effects on Special-Status Mammal Species.*** Compared to the No-Action Alternative, Alternative B could affect special-status mammal species. Construction-related effects on special-status mammal species would generally be the same as those described for Alternative A (see Impact WILD-4 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative B would create a wide, consensus-based floodplain. The wide floodplain would generally affect more habitat for special-status mammals during construction, including areas near the river and at temporary staging areas, than Alternative A (see Table 7-6). However, most of this habitat would remain unchanged or be restored to natural habitats upon Project completion and less Western mastiff bat and American Badger habitat would be converted to Project infrastructure than Alternative A. Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status mammals (see Impact WILD-4 [Alternative A] and Table 2-8). The wide floodplain featured in Alternative B may provide more foraging habitat (compared to the narrow floodplain in Alternative A or the No-Action Alternative) for bat species. Under this alternative, portions of the floodplain and associated riparian habitat would be actively restored. Following construction of Alternative B Project components, wetland, floodplain, and riparian areas in the active restoration portion would be planted and irrigated until vegetation is established (see Chapter 2.0, "Description of Alternatives").

When comparing Alternative B to existing conditions, impacts to special-status mammals would generally be the same as described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). Because impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and active restoration of riparian habitats would occur, the impacts are considered **less than significant**.

Impact WILD-5 (Alternative B): ***Adverse Effects on Wildlife Movement Corridors.*** Compared to the No-Action Alternative, Alternative B could affect wildlife movement along migration corridors. Construction-related effects on migration corridors would generally be the same as those described for Alternative A (see Impact WILD-5 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative B would create a wide, consensus-based floodplain, which would provide a larger riparian corridor for movement. Project construction periods would be longer than Alternative A, but post-project conditions would most likely improve habitat for migrating species, especially because portions of the floodplain would be actively restored for Alternative B.

When comparing Alternative B to existing conditions, impacts to movement corridors would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). Most of these impacts would be temporary and would occur intermittently within the overall construction timeframe for the entire Project. Post-project conditions would return natural habitats to much of the disturbed areas and are expected to increase riparian vegetation, potentially improving conditions for migratory species. Impacts of Alternative B to movement corridors are considered **less than significant.**

Impact WILD-6 (Alternative B): ***Long-term Habitat Improvement in Reach 2B.*** Compared to the No-Action Alternative, Restoration Flows in Reach 2B would be conveyed through an expanded floodplain. Wetland communities would develop within the main channel, a dense riparian scrubland would develop along the main river channel banks, and bands of other habitat types (wetland, scrub, grassland, and forest) would develop at higher elevations along the channel corridor. The wetland, floodplain, and riparian areas in the active restoration portion would be planted following construction and then irrigated and managed as necessary during the establishment period.

Active riparian and floodplain habitat restoration would improve native floodplain and in-channel habitats, which would likely benefit native and potentially special-status species. Benefits to native species would be realized through the re-introduction of perennial base flows as well as seasonal high flows in the river, which in turn would promote the establishment of riparian vegetation. Well-established native plant communities in the floodplain would support rich and diverse native flora, potentially including special-status plant species, and would provide foraging habitat and shelter for native wildlife species.

When comparing Alternative B to existing conditions, effects on long-term opportunities for habitat improvement in Reach 2B would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative B to the No-Action Alternative). According to habitat restoration estimates, Alternative B could provide up to 1,870 acres of wildlife habitat and up to 1,640 acres of special-status species habitat (not mutually exclusive areas) (SJRRP 2012, Attachment A). For many of these habitat types, this represents a 3- to 9-fold increase in habitat as compared to existing conditions. In general, implementation of Alternative B would cause a **beneficial** effect on wildlife habitat.

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a new levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Similar to Alternative B, Alternative C includes active riparian and floodplain habitat restoration. It is assumed that wetland communities and a dense riparian scrubland would develop along the main channel and river banks, respectively, and bands of other habitat types (wetland, scrub, grassland, and forest) would develop at higher elevations along the channel corridor. The wetland, floodplain, and riparian areas would be planted following construction and then irrigated and managed as necessary during the establishment period.

Table 7-7 summarizes habitat impacts by acreage for all vertebrate species. These acreages represent the worst-case scenario where all existing floodplain areas are assumed to be impacted.

Table 7-7.
Species Habitat Potentially Affected by Alternative C

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat)	(not future habitat)	(future habitat or agriculture)	
Reptiles and Amphibians						
Actinemys marmorata	western pond turtle	Aquatic	167	26	44	32
		Upland	203	20	46	7
Anniella pulchra pulchra	silvery legless lizard	Habitat	372	46	214	36
Gambelia sila	blunt-nosed leopard lizard	Habitat	5	9	0	0
Masticophis flagellum ruddocki	San Joaquin coachwhip	Habitat	92	14	200	11
Phrynosoma blainvillii	coast horned lizard	Habitat	174	26	202	15
Spea hammondii	western spadefoot	Breeding Habitat	0.0	0.3	0	0
Thamnophis gigas	giant garter snake	Aquatic	167	26	44	32
		Upland	203	20	46	7
Birds						
Agelaius tricolor	tricolored blackbird	Foraging	250	26	≤350	24
		Nesting	108	9	95	16
Anser albifrons elgasi	greater white-fronted goose	Foraging	263	27	45	33
Asio flammeus	short-eared owl	Foraging and Nesting	95	18	200	11
		Foraging	159	12	≤350	21
Athene cunicularia	burrowing owl	Foraging and Nesting	95	18	200	11
		Foraging	159	12	≤350	21
Aythya americana	redhead	Foraging	221	18	41	26
		Nesting	42	9	3	7
Buteo swainsoni	Swainson's hawk	Foraging	318	30	≤350	24
		Nesting	280	32	14	24
Charadrius montanus	mountain plover	Foraging	254	30	≤350	33
Circus cyaneus	northern harrier	Foraging	162	15	≤350	21
		Nesting	199	24	204	19

Table 7-7.
Species Habitat Potentially Affected by Alternative C

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat)	(not future habitat)	(future habitat or agriculture)	
Elanus leucurus	white-tailed kite	Foraging	358	36	≤350	40
		Nesting	280	32	14	24
Grus canadensis canadensis	lesser sandhill crane	Foraging	358	36	≤350	40
Grus canadensis tabida	greater sandhill crane	Foraging	358	36	≤350	40
Lanius ludovicianus	loggerhead shrike	Foraging	251	26	≤350	33
		Foraging and Nesting	3	4	0	0
Numenius americanus	long-billed curlew	Foraging	254	30	≤350	33
Pelecanus erythrorhynchos	American white pelican	Foraging	263	27	45	33
Xanthocephalus xanthocephalus	yellow-headed blackbird	Foraging	251	26	≤350	33
		Nesting	107	9	4	7
Mammals						
Dipodomys nitratoides exilis	Fresno kangaroo rat	Habitat	5	9	0	0
Eumops perotis californicus	Western mastiff bat	Foraging	439	52	≤350	42
Lasiurus blossevillii	Western red bat	Roosting and Foraging	868	135	≤350	83
Taxidea taxus	American badger	Habitat	92	14	200	11

Notes:
Floodplain = floodplain of the San Joaquin River (active restoration)
Infrastructure = structures, levees, or roads
Borrow = maximum amount disturbed to take fill materials for levees (reseeded)
Other = construction staging areas, temporary access roads, and other construction-related disturbances (reseeded)

Impact WILD-1 (Alternative C): ***Project Effects on Special-Status Invertebrate Species.*** Compared to the No-Action Alternative, Alternative C could affect special-status invertebrate species. Construction-related effects on special-status invertebrate species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative C would use the river channel for Restoration Flow and the Short Canal to convey water from the San Joaquin River to Mendota Pool (and excludes the South Canal and associated levees). Differences would result in effects on three more elderberry shrubs, in comparison to Alternative A. Up to 633 shrubs are potentially affected by Alternative C. Conservation Measures VELB-1 includes pre-construction surveys for elderberry shrubs and avoidance of elderberry shrubs found in the Project area, to the extent feasible (Table 2-8). Future floodplain areas would be allowed to return to natural habitats after Project construction is complete, which would provide suitable habitat for elderberry shrubs after construction is complete, especially along the main river channel banks where many of the elderberry shrubs occur now. Though both Alternatives A and C include plans for a narrow floodplain, Alternative C features active riparian and floodplain restoration and would not include agricultural or grazing use within the floodplain. Implementation of Alternative C would result in more riparian habitat over the long-term and potentially more elderberry shrub habitat than Alternative A.

Construction activity under Alternative C is expected to take 133 months, which is a similar duration as Alternative A.

When comparing Alternative C to existing conditions, impacts to special-status invertebrate species would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). Because the valley elderberry longhorn beetle is no longer expected to occur in the Project area, the completed Project would provide habitat for elderberry shrubs, and implementation of Project conservation measures will reduce impacts to elderberry shrubs, the impacts are considered **less than significant**.

Impact WILD-2 (Alternative C): ***Project Effects on Special-Status Reptile and Amphibian Species.*** Compared to the No-Action Alternative, Alternative C could affect some special-status reptile and amphibian species. Construction-related effects on special-status reptile and amphibian species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative C would include the construction of the Fresno Slough Dam and the Short Canal. This change would result in adverse effects to more habitats for special-status reptiles and amphibians in areas near the river, compared to Alternative A (see Table 7-7). Under Alternative C, less habitat area would be converted to Project infrastructure for most special-status reptile and amphibian species, with the exception of the aquatic and wetland habitats for the giant garter snake, the western pond turtle, and the western spadefoot. Alternative C would use the river channel to convey Restoration Flows through Reach 2B (instead of a Compact Bypass). This method essentially removes the slackwater habitat for giant garter snake in the San Joaquin arm of Mendota Pool following Project completion. Whereas, Alternative A would retain a small portion of slackwater habitat between the Mendota Dam and the Mendota Pool Dike (see Impact WILD-2 [Alternative A]). Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status reptiles and amphibians (see Impact WILD-2 (Alternative A) and Table 2-8).

Alternative C would affect nearly the same amount of potential habitat for blunt-nosed leopard lizard as Alternative A, but a smaller portion of the habitat affected would be converted to Project infrastructure than under Alternative A, potentially resulting in a lesser long-term effect on this species (if present). All adverse effects would be avoided and/or mitigated with implementation of the Conservation Measures BNLL-1 (Table 2-8). As a fully-protected species, direct take of blunt-nosed leopard lizards would be prohibited.

When comparing Alternative C to existing conditions, impacts to special-status reptiles and amphibians would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). Because these impacts would be largely temporary, would occur intermittently within the overall construction timeframe, and because conservation measures are in place to reduce, minimize, and compensate for impacts, they are considered **less than significant.**

Impact WILD-3 (Alternative C): ***Project Effects on Special-Status Bird Species.*** Compared to the No-Action Alternative, Alternative C could affect special-status bird species. Construction-related effects on special-status bird species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions. Unlike Alternative A, Alternative C would include the construction of the Fresno Slough Dam and the Short Canal. This change would result in temporary adverse effects to more habitat for most special-status birds than Alternative A (see Table 7-7) but for most species, less of this habitat would be converted to Project infrastructure. Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status birds (see Impact WILD-3 (Alternative A) and Table 2-8).

Though both Alternatives A and C include plans for a narrow floodplain, Alternative C features active riparian and floodplain restoration and would not include agricultural or grazing use within the floodplain. Implementation of Alternative C would result in more riparian habitat, and thus available nesting habitat for Swainson's hawks, white-tailed kites, and short-eared owls. In comparison to Alternative A and the No-Action Alternative, post-project conditions may provide less foraging habitat for birds that use open, grassland or crop cover, including mountain plovers, loggerhead shrikes, long-billed curlews, and yellow-headed blackbirds.

When comparing Alternative C to existing conditions, impacts to special-status birds would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). Because the majority of these impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and active restoration of riparian habitats would occur, they are considered **less than significant**.

Impact WILD-4 (Alternative C): ***Project Effects on Special-Status Mammal Species.*** Compared to the No-Action Alternative, Alternative C could affect special-status mammal species. Construction-related effects on special-status mammal species would generally be the same as those described for Alternative A (see Impact WILD-4 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative C would include the construction of the Fresno Slough Dam and the Short Canal. These changes would convert less habitat area for special-status mammals to Project infrastructure, though slightly more habitat area would be affected temporarily for American badger (see Table 7-7). Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status mammals (see Impact WILD-4 [Alternative A] and Table 2-8).

Following construction of Alternative C Project components, wetland, floodplain, and riparian areas would be planted and irrigated until vegetation is established (see Chapter 2.0, "Description of Alternatives"). Though both Alternatives A and C include plans for a narrow floodplain, active restoration and restriction of agricultural or grazing use within the floodplain would result in more riparian habitat, which would be beneficial to the western red bat and the western mastiff bat.

When comparing Alternative C to existing conditions, impacts to special-status mammals would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). Because impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and active restoration of riparian habitats would occur, the impacts are considered **less than significant**.

Impact WILD-5 (Alternative C): ***Adverse Effects on Wildlife Movement Corridors.*** Compared to the No-Action Alternative, Alternative C could affect wildlife movement along migration corridors. Construction-related effects on migration corridors would generally be the same as those described for Alternative A (see Impact WILD-5 [Alternative A]), with several exceptions.

Following construction of Alternative C Project components, wetland, floodplain, and riparian areas would be planted and irrigated until vegetation is established (see Chapter 2.0, "Description of Alternatives"). Though both Alternatives A and C include plans for a narrow floodplain, this active restoration and restriction of agricultural or grazing use within the floodplain would result in more riparian habitat, potentially providing better cover and forage for migrating wildlife.

When comparing Alternative C to existing conditions, impacts to movement corridors would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). Most of these impacts would be temporary and would occur intermittently within the overall construction timeframe for the entire Project. Post-project conditions would return natural habitats to much of the disturbed areas and are expected to increase riparian vegetation, potentially improving conditions for migratory species. Impacts of Alternative C to movement corridors are considered **less than significant.**

Impact WILD-6 (Alternative C): ***Long-term Habitat Improvement in Reach 2B.*** Compared to the No-Action Alternative, Restoration Flows in Reach 2B would be conveyed through an expanded floodplain. Wetland communities would develop within the main channel, a dense riparian scrubland would develop along the main river channel banks, and bands of other habitat types (wetland, scrub, grassland, and forest) would develop at higher elevations along the channel corridor. The wetland, floodplain, and riparian areas would be planted following construction and then irrigated and managed as necessary during the establishment period.

Active riparian and floodplain habitat restoration would improve native floodplain and in-channel habitats, which would likely benefit native and potentially special-status species. Benefits to native species would be realized through the re-introduction of perennial base flows as well as seasonal high flows in the river, which in turn would promote the establishment of riparian vegetation. Well-established native plant communities in the floodplain would support rich and diverse native flora, potentially including special-status plant species, and would provide foraging habitat and shelter for native wildlife species.

When comparing Alternative C to existing conditions, effects on long-term opportunities for habitat improvement in Reach 2B would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). According to habitat restoration estimates, Alternative C could provide up to 1,360 acres of wildlife habitat and up to 1,050 acres of special-status species habitat (not mutually exclusive areas) (SJRRP 2012, Attachment A). For many of these habitat types, this represents a 2- to 5-fold increase in habitat as compared to existing conditions. In general, implementation of Alternative C would cause a **beneficial** effect on wildlife habitat.

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a new levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the North Canal bifurcation structure, and the North Canal fish passage facility, removal of the San Joaquin River control structure of the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Similar to Alternative A, Alternative D includes passive riparian habitat restoration and agricultural practices in the floodplain. It is assumed that over time wetland communities and a dense riparian scrubland would develop along the main channel and river banks, respectively. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, limited agricultural practices (e.g., pasture) would occur.

Table 7-8 summarizes habitat impacts by acreage for all vertebrate species with the potential to occur in the Project area. These acreages represent the worst-case scenario where all existing floodplain areas are assumed to be impacted.

Table 7-8.
Species Habitat Potentially Affected by Alternative D

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Reptiles and Amphibians						
Actinemys marmorata	western pond turtle	Aquatic	166	30	45	33
		Upland	200	22	46	8
Anniella pulchra pulchra	silvery legless lizard	Habitat	363	59	207	29
Gambelia sila	blunt-nosed leopard lizard	Habitat	5	9	0	0
Masticophis fla-gellum ruddocki	San Joaquin coachwhip	Habitat	88	13	200	9
Phrynosoma blainvillii	coast horned lizard	Habitat	166	30	202	9
Spea hammondii	western spadefoot	Breeding Habitat	0.0	0.3	0	0
Thamnophis gigas	giant garter snake	Aquatic	166	30	45	33
		Upland	200	22	46	8
Birds						
Agelaius tricolor	tricolored blackbird	Foraging	275	132	≤350	20
		Nesting	108	8	95	17
Anser albifrons elgasi	greater white-fronted goose	Foraging	260	33	46	33
Asio flammeus	short-eared owl	Foraging and Nesting	91	17	200	9
		Foraging	188	119	≤350	19
Athene cunicularia	burrowing owl	Foraging and Nesting	91	17	200	9
		Foraging	188	119	≤350	19
Aythya americana	redhead	Foraging	218	26	42	25
		Nesting	42	7	3	9
Buteo swainsoni	Swainson's hawk	Foraging	342	136	≤350	20
		Nesting	275	46	7	19
Charadrius montanus	mountain plover	Foraging	279	135	≤350	29
Circus cyaneus	northern harrier	Foraging	191	122	≤350	19
		Nesting	195	21	204	18
Elanus leucurus	white-tailed kite	Foraging	383	140	≤350	38
		Nesting	275	46	7	19

Table 7-8.
Species Habitat Potentially Affected by Alternative D

Scientific Name	Common Name	Habitat Type	Maximum Impacted Area (acres)			
			Floodplain	Infrastructure	Borrow	Other
			(future habitat or agriculture)	(not future habitat)	(future habitat or agriculture)	
Grus canadensis canadensis	lesser sandhill crane	Foraging	383	140	≤350	38
Grus canadensis tabida	greater sandhill crane	Foraging	383	140	≤350	38
Lanius ludovicianus	loggerhead shrike	Foraging	276	132	≤350	29
		Foraging and Nesting	3	4	0	0
Numenius americanus	long-billed curlew	Foraging	279	135	≤350	29
Pelecanus erythrorhynchos	American white pelican	Foraging	260	33	46	33
Xanthocephalus xanthocephalus	yellow-headed blackbird	Foraging	276	132	≤350	29
		Nesting	107	8	4	9
Mammals						
Dipodomys nitratoides exilis	Fresno kangaroo rat	Habitat	5	9	0	0
Eumops perotis californicus	Western mastiff bat	Foraging	459	169	≤350	34
Lasiurus blossevillii	Western red bat	Roosting and Foraging	1,221	271	≤350	70
Taxidea taxus	American badger	Habitat	88	13	200	9

Notes:
Floodplain = floodplain of the San Joaquin River (passive restoration and agricultural activities)
Infrastructure = structures, levees, or roads
Borrow = maximum amount disturbed to take fill materials for levees (reseeded)
Other = construction staging areas, temporary access roads, and other construction-related disturbances (reseeded)

Impact WILD-1 (Alternative D): ***Project Effects on Special-Status Invertebrate Species.*** Compared to the No-Action Alternative, Alternative D could affect special-status invertebrate species. Construction-related effects on special-status invertebrate species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative D would use the river channel for Restoration Flows and the North Canal to convey water from the San Joaquin River to Mendota Pool. These infrastructure differences would result in no difference in effects on elderberry shrubs, in comparison to Alternative A. Up to 630 shrubs are potentially affected with Alternative D. Conservation Measures VELB-1 includes pre-construction surveys for elderberry shrubs and avoidance of elderberry shrubs found in the Project area, to the extent feasible (Table 2-8). The future floodplain area would be allowed to return to natural habitats after Project construction is complete, which would provide suitable habitat for elderberry shrubs after construction is complete, especially along the main river channel banks where many of the elderberry shrubs occur now.

Construction activity under Alternative D is expected to take 158 months, therefore, adverse effects of construction would occur over an approximately 2 year longer period compared to Alternative A. Alternatives A and D both allow for agricultural or grazing use within the floodplain.

When comparing Alternative D to existing conditions, impacts to special-status invertebrate species would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). Because the valley elderberry longhorn beetle is no longer expected to occur in the Project area, implementation of Project conservation measures will reduce impacts to elderberry shrubs, and because the completed Project would provide habitat for elderberry shrubs, Project impacts are considered **less than significant**.

Impact WILD-2 (Alternative D): ***Project Effects on Special-Status Reptile and Amphibian Species*****.** Compared to the No-Action Alternative, Alternative D could affect some special-status reptile and amphibian species. Construction-related effects on special-status reptile and amphibian species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

The features of Alternative D would displace more habitat for silvery legless lizards. Habitats converted to Project infrastructure would be less for the other special-status reptile and amphibian species, excepting the aquatic and wetland habitats for the giant garter snake the western pond turtle, and the western spadefoot (see Table 7-8). Alternative D would use the river channel to convey Restoration Flows through Reach 2B (instead of a Compact Bypass). This method essentially removes the slackwater habitat for giant garter snake in the San Joaquin arm of Mendota Pool following Project completion (see Impact WILD-2 [Alternative A]). Similar to Alternative A, measures would be implemented to minimize adverse effects to special-status reptiles and amphibians (see Impact WILD-2 [Alternative A] and Table 2-8).

Alternative D would potentially affect slightly less total habitat for blunt-nosed leopard lizard than Alternative A and less of the habitat affected would be converted to Project infrastructure. All adverse effects would be avoided and/or mitigated with implementation of the Conservation Measures BNLL-1 (Table 2-8). As a fully-protected species, direct take of blunt-nosed leopard lizards would be prohibited.

Construction activity under Alternative D is expected to take 158 months, therefore, adverse effects of construction would occur over an approximately 2 year longer period compared to Alternative A.

When comparing Alternative D to existing conditions, impacts to special-status reptiles and amphibians would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). Because these impacts would be largely temporary, would occur intermittently within the overall construction timeframe, and conservation measures are in place to reduce, minimize, and compensate for impacts, they are considered **less than significant.**

Impact WILD-3 (Alternative D): ***Project Effects on Special-Status Bird Species*.** Compared to the No-Action Alternative, Alternative D could affect special-status bird species. Construction-related effects on special-status bird species would generally be the same as those described for Alternative A (see Impact WILD-1 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative D would include the construction of the Fresno Slough Dam and the North Canal. These changes would result in adverse effects to more habitat for all of the special-status birds in areas near the river, than Alternative A (see Table 7-8). For a few of these species (including the nesting habitats of burrowing owls, tricolored blackbirds, short-eared owls, and northern harriers), less of this habitat would be converted to long-term infrastructure. Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status birds (see Impact WILD-3 (Alternative A) and Table 2-8).

Both Alternatives A and D allow for agricultural or grazing use within the floodplain. In comparison to Alternative A (narrow floodplain), post-project conditions of Alternative D (wide floodplain) may provide more foraging habitat for birds that use open, grassland or crop cover, including mountain plovers, loggerhead shrikes, long-billed curlews, and yellow-headed blackbirds.

Construction activity under Alternative D is expected to take 158 months, therefore, adverse effects of construction would occur over an approximately 2 year longer period compared to Alternative A.

When comparing Alternative D to existing conditions, impacts to special-status birds would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). Because the majority of these impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and active restoration of riparian habitats would occur, they are considered **less than significant**.

Impact WILD-4 (Alternative D): ***Project Effects on Special-Status Mammal Species.*** Compared to the No-Action Alternative, Alternative D could affect special-status mammal species. Construction-related effects on special-status mammal species would generally be the same as those described for Alternative A (see Impact WILD-4 [Alternative A]), with several exceptions.

Unlike Alternative A, Alternative D would include the construction of the Fresno Slough Dam and North Canal. More habitat for special-status mammal species would be disturbed by construction activities near the river, though less habitat for American badgers and Fresno kangaroo rats would be converted to Project infrastructure (see Table 7-8). Similar to Alternative A, measures would be implemented to minimize these adverse effects to special-status mammals (see Impact WILD-4 [Alternative A] and Table 2-8).

Construction activity under Alternative D is expected to take 158 months, therefore, adverse effects of construction would occur over an approximately 2 year longer period compared to Alternative A.

When comparing Alternative D to existing conditions, impacts to special-status mammals would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). Because these impacts would be temporary and would occur intermittently within the overall construction timeframe, conservation measures are in place to reduce and minimize impacts, and active restoration of riparian habitats would occur, the impacts are considered **less than significant**.

Impact WILD-5 (Alternative D): ***Adverse Effects on Wildlife Movement Corridors*.** Compared to the No-Action Alternative, Alternative D could affect wildlife movement along migration corridors. Construction-related effects on migration corridors would generally be the same as those described for Alternative A (see Impact WILD-5 [Alternative A]), with several exceptions**.**

Alternative A includes plans for a San Mateo Avenue crossing. In Alternative D, this crossing would be removed. This would not alter bird movement, but the crossing may provide a way for other terrestrial species to cross the river. Compared to the No-Action Alternative, the restoration of a riparian corridor would facilitate movement and provide habitat for many special-status species, including Swainson's hawks, white-tailed kites, tricolored blackbirds, yellow-headed blackbirds, western red bats, and elderberry shrubs, the host plant for valley elderberry longhorn beetles.

When comparing Alternative D to existing conditions, impacts to movement corridors would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). Most of these impacts would be temporary and would occur intermittently within the overall construction timeframe for the entire Project. Post-project conditions would return natural habitats to much of the disturbed areas and are expected to increase riparian vegetation, potentially improving conditions for migratory species. Impacts of Alternative D to movement corridors are considered **less than significant.**

Impact WILD-6 (Alternative D): ***Long-term Habitat Improvement in Reach 2B.*** Compared to the No-Action Alternative, Restoration Flows in Reach 2B would be conveyed through an expanded floodplain. Over time wetland communities would develop within the main channel and a dense riparian scrubland would develop along the main river channel banks. The Restoration Flows would be used to recruit new vegetation along the channel from the existing seed bank. Between the main river channel banks and the proposed levees, limited agricultural practices (e.g., pasture) would occur.

Passive riparian habitat restoration of the San Joaquin River would improve native floodplain and in-channel habitats, which would likely benefit native and potentially special-status species such as Swainson’s hawk and greater sandhill crane. Benefits to native species would be realized through the re-introduction of perennial base flows as well as seasonal high flows in the river, which in turn would promote the establishment of riparian vegetation. Well-established native plant communities in the floodplain would support rich and diverse native flora, including potentially special-status plant species, and would provide foraging habitat and shelter for native wildlife species.

When comparing Alternative D to existing conditions, effects on long-term opportunities for habitat improvement in Reach 2B would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative D to the No-Action Alternative). According to habitat restoration estimates, Alternative D could provide up to 1,900 acres of wildlife habitat and up to 1,630 acres of special-status species habitat (not mutually exclusive areas) (SJRRP 2012, Attachment A). For many of these habitat types, this represents a 3- to 9-fold increase in habitat as compared to existing conditions. In general, implementation of Alternative D would cause a **beneficial** effect on wildlife habitat.

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8.0 Climate Change and Greenhouse Gas Emissions

This chapter describes the environmental and regulatory setting for climate change and greenhouse gas emissions, as well as the environmental consequences associated with the construction and operation of Project alternatives, including impacts and mitigation measures.

8.1 Environmental Setting

8.1.1 Greenhouse Gases

Radiation from the sun is the primary source of energy keeping the earth warm enough for life. Solar radiation enters the earth's atmosphere, a portion of the radiation passes through the atmosphere and is absorbed by the earth's surface (this is primarily radiation in the visible portion of the electromagnetic spectrum), a portion is reflected back toward space, and a portion is absorbed by the upper atmosphere. The radiation absorbed by the earth heats the earth's surface which then emits infrared radiation. Since the earth has a much lower temperature than the sun, it emits longer wavelength radiation.[1]

Certain gases in the earth's atmosphere, classified as greenhouse gases (GHGs), play a critical role in determining the earth's surface temperature. GHGs have strong absorption properties at wavelengths that are emitted by the earth. As a result, radiation that otherwise would have escaped back into space is instead "trapped," resulting in a warming of the atmosphere. This phenomenon, known as the "greenhouse effect," is responsible for maintaining a habitable climate on Earth.

Prominent GHGs contributing to the greenhouse effect are water vapor, carbon dioxide (CO_2), methane, ozone, nitrous oxide (N_2O), and fluorinated compounds (chlorofluoro-carbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride). Human-caused emissions of these GHGs in excess of natural ambient concentrations are responsible for intensifying the greenhouse effect and have led to a warming trend of the earth's climate, known as global climate change or global warming. Global temperatures have increased over the past 50 years and it is unlikely that the increase can be explained without the contribution of GHGs from human activities (Intergovernmental Panel on Climate Change [IPCC] 2014).

Although preliminary research has also found localized effects from GHGs, climate change is largely a global problem. GHGs pollutants have global implications, unlike criteria air pollutants and toxic air contaminants, which are pollutants of regional and local concern. Whereas pollutants with localized air quality effects have relatively short

[1] The wavelength at which a body emits radiation is proportional to the temperature of the body.

atmospheric lifetimes (e.g., about 1 day), GHGs have long atmospheric lifetimes (1 year to several thousand years). GHGs persist in the atmosphere for long enough time periods to be dispersed around the globe. CO_2 is one of the major human contributed GHGs. Of the total annual human-caused CO_2 emissions, less than 45 percent is sequestered (removed from the atmosphere and stored) through ocean uptake, uptake by northern hemisphere forest regrowth, and other terrestrial sinks. The remaining human-caused CO_2 emissions remain stored in the atmosphere (IPCC 2014, Ballantyne et al. 2012).

The atmosphere and the oceans are reaching their capacity to absorb CO_2 and other GHGs, without significantly changing the Earth's climate. The increase in GHGs in the Earth's climate is projected to affect a wide range of issues and resources, including sea-level rise, flooding, water supply, agricultural and forestry resources, and energy demand. California's Climate Change Portal (www.climatechange.ca.gov) states:

> *Climate change is expected to have significant, widespread impacts on California's economy and environment. California's unique and valuable natural treasures - hundreds of miles of coastline, high value forestry and agriculture, snow-melt fed fresh water supply, vast snow and water fueled recreational opportunities, as well as other natural wonders - are especially at risk.*

In addition, the IPCC, in the section of its Fifth Assessment Report by Working Group II, "Climate Change 2014: Impacts, Adaptation, and Vulnerability" (IPCC 2014; released March 31, 2014), specific to North America (Chapter 26), stated in part:

> *North American ecosystems are under increasing stress from rising temperatures, CO_2 concentrations, and sea-levels, and are particularly vulnerable to climate extremes (very high confidence). Climate stresses occur alongside other anthropogenic influences on ecosystems, including land-use changes, non-native species, and pollution, and in many cases will exacerbate these pressures (very high confidence) [26.4.1; 26.4.3]. Evidence since the Fourth Assessment Report (IPCC 2007) highlights increased ecosystem vulnerability to multiple and interacting climate stresses in forest ecosystems, through wildfire activity, regional drought, high temperatures, and infestations (medium confidence) [26.4.2.1; Box 26-2]; and in coastal zones due to increasing temperatures, ocean acidification, coral reef bleaching, increased sediment load in run-off, sea level rise, storms, and storm surges (high confidence) [26.4.3.1]*.

California has already been affected by climate change: sea-level rise, increased average temperatures, more extreme hot days and increased heat waves, fewer shifts in the water cycle, and increased frequency and intensity of wildfires. Higher sea levels can result in increased coastal erosion (which may have a secondary effect, such as uncovering shoreline hazards), more frequent flooding from storm surges, increased property damage, and reduced waterfront public access options. Other projected climate change impacts in California include: decreases in the water quality of surface waterbodies, groundwater, and coastal waters; decline in aquatic ecosystem health; lowered profitability for water-intensive crops; changes in species and habitat distribution; and impacts to fisheries (California Regional Assessment Group 2002). These effects are expected to increase with rising GHG levels in the atmosphere.

The quantity of GHGs that it takes to cause a change in climate is not precisely known; however, the quantity is enormous. The estimated global annual emission of anthropogenic GHGs was 46 billion metric tons in 2010 (U.S. Environmental Protection Agency [EPA] 2014a). Of this, agriculture was estimated to contribute about 11.5 percent, or about 5.3 billion metric tons of GHGs (Food and Agriculture Organization of the United Nations 2014). This compares with the estimated emissions from California of 0.453 billion metric tons or about 1 percent of the global emissions (California Air Resources Board [ARB] 2014a). Emissions of GHGs contributing to global climate change are attributable in large part to human activities associated with the burning of fossil fuels, industrial/manufacturing, transportation, and agricultural sectors, as well as land use change (EPA 2014a).

California is the 15th largest emitter of CO_2 in the world (California Air Resources Board [ARB] 2011). California produced 451.6 teragrams (Tg; or million metric tons) of CO_2 equivalents[2] (CO_2e) in 2010 (ARB 2013). The five major fuel consuming sectors contributing to CO_2 emissions from fossil fuel combustion are transportation, electricity generation, industrial, residential, and commercial. Combustion of fossil fuel in the transportation sector was the single largest source of California's GHG emissions, accounting for 38 percent of total GHG emissions in California. This sector was followed by the electric power sector (including both in-state and out-of-state sources) at 21 percent and the industrial sector at 19 percent (ARB 2013).

Methane is a highly potent GHG that results from off-gassing (the release of chemicals from nonmetallic substances under ambient or greater pressure conditions) largely associated with agricultural practices, landfills, and wetlands. CO_2 sinks, or reservoirs, include vegetative growth (which convert CO_2 to biomass) and the ocean, which absorbs CO_2 through photosynthesis by phytoplankton and dissolution, respectively, two of the most common processes of CO_2 sequestration (EPA 2014b).

Agriculture activities contributed 32.4 Tg CO_2e or 7 percent of California emissions. Of the 32.4 Tg CO_2e, agricultural emissions from crop growing and harvesting (including soil management and rice cultivation) accounted for 10 Tg CO_2e (ARB 2013). The remainder was mainly due to enteric fermentation for livestock and manure management (Figure 8-1).

The Project would involve changes to agriculture, wetlands, and riparian zones. The basic GHG emissions associated with these land use and management types is described below.

[2] CO_2e is a measurement used to account for the fact that different GHGs have different potential to retain infrared radiation in the atmosphere and contribute to the greenhouse effect. This potential, known as the global warming potential (GWP) of a GHG, is dependent on the lifetime, or persistence, of the gas molecule in the atmosphere. Expressing emissions in CO_2e takes the contributions of all GHG emissions to the greenhouse effect and converts them to a single unit equivalent to the effect that would occur if only CO_2 were being emitted.

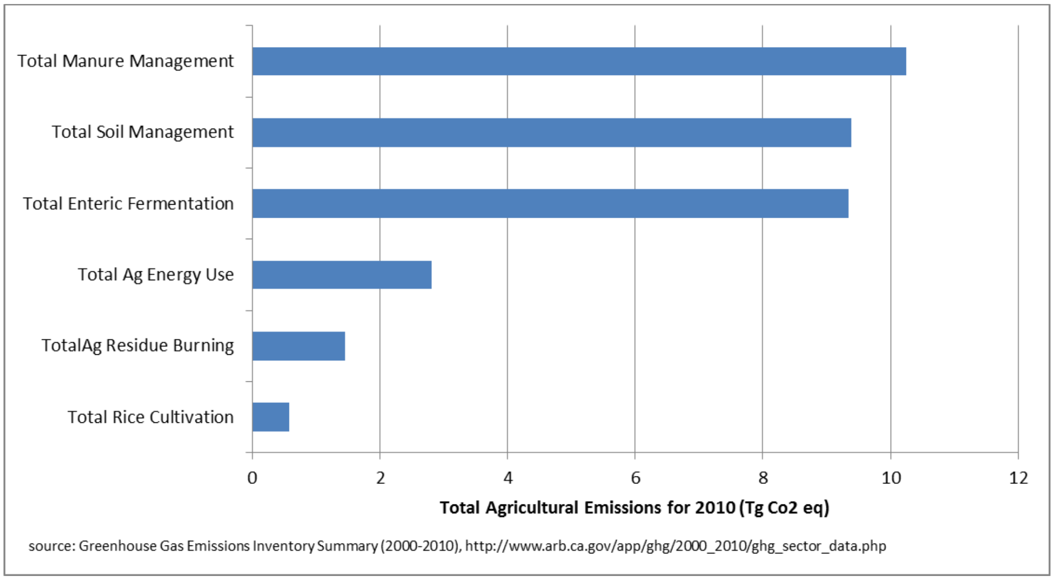

Figure 8-1.
2010 Estimated Breakdown of Agricultural GHG Sources for California

Agricultural soils emit N_2O, but act as net sinks for CO_2. In the United States, agricultural soils have accounted for approximately 75 percent of N_2O emissions and 5 percent of total emissions in 2012 (EPA 2014b). While total N_2O emissions are much lower than CO_2 emissions, N_2O is approximately 300 times more powerful than CO_2 at trapping heat in the atmosphere. Estimated emissions from agricultural soils were 306.6 Tg CO_2e in 2012 (EPA 2014b).

Nitrous oxide is produced naturally in soils through the microbial processes of nitrification and denitrification. A number of agricultural activities increase mineral Nitrogen (mineral N) availability in soils, thereby increasing the amount available for nitrification and denitrification, and ultimately the amount of N_2O emitted. These activities increase soil mineral N either directly or indirectly. Management practices that add or lead to greater release of direct emissions include fertilization, application of manure and other organic materials, deposition of manure on soils by domesticated animals in pastures, rangelands, and paddocks, production of N-fixing crops and forages, retention of crop residues, and drainage and cultivation of organic cropland soils (i.e., soils with a high organic matter content, for example peat soils as found in the Delta). Other agricultural soil management activities, including irrigation, drainage, tillage practices, and fallowing of land, can influence N mineralization in soils and thereby affect direct emissions. Mineral N is also made available in soils through decomposition of soil organic matter and plant litter, as well as asymbiotic fixation of N from the atmosphere, and these processes are influenced by agricultural management through impacts on moisture and temperature regimes in soils. Indirect emissions of N_2O occur through two pathways: (1) volatilization and subsequent atmospheric deposition of applied/mineralized N, and (2) surface runoff and leaching of applied/mineralized N into groundwater and surface water (Massy and Ulmer 2010, EPA 2014b).

Soils contain both organic and inorganic forms of carbon. Soil organic carbon stocks are the main source and sink for atmospheric CO_2 in most soils and account for about 1 percent of the total net CO_2 flux in the United States (EPA 2014b). In agricultural soils, mineral and organic soils sequester approximately four times as much carbon as is emitted from these soils through liming and urea fertilization. Net carbon uptake is largely due to a reduction in summer fallow areas in semi-arid areas, the adoption of conservation tillage practices, and application of organic fertilizers to agriculture lands. Although CO_2 is sequestered in agricultural soils, the amount of CO_2 uptake is small compared to CO_2e emitted as N_2O.

Wetlands are one of the largest natural sources of GHGs and are the major natural source of methane due to high rates of methanogenesis enabled by the presence of anaerobic soils (Altor and Mitsch 2006). Wetland plants uptake CO_2, which is converted to biomass and stored in organic soils. This storage of carbon in organic soils has resulted in a large carbon pool. The creation of wetlands can result in either a net increase or decrease in GHGs depending upon the time frame of interest and the characteristics of the wetland. On a mole for mole basis,[3] methane is a much more potent GHG than is CO_2. Over a 100-year time frame, it has about 21 times as much global warming potential (GWP)[4] as CO_2. Over shorter time frames, it has an even greater GWP due to the lifetime of methane in the atmosphere. Methane is oxidized to CO_2 and carbon monoxide (CO) in about 10 years. So in general, a wetland can initially be considered a net GHG source and over time as more carbon is sequestered in organic soils a net GHG sink. The time required for the wetland to change from a net source to a net sink depends upon the ratio of carbon emitted as methane to carbon sequestered as CO_2. Whiting and Chanton (2001) studied the rate of sequestration of carbon and the rate of methane emission from several different types of wetlands. Their data showed that the wetlands they studied would be net sources for 20 years, some sources and some sinks after 100 years, and all sinks after 500 years. However, estimates of the GWP have increased since their study, so their results can be considered as low estimates.

Riparian zones that are oxic (contain oxygen) are net sinks for methane and sources of N_2O. Aerated soil contains methanotrophic bacteria that use methane as their carbon source. N_2O is produced in riparian soils primarily through decomposition of soil organic matter and plant litter, as well as asymbiotic fixation of N from the atmosphere. Tanzosh (2005) studied two watersheds in Ohio, each of which contained upland agricultural land, riparian grassland and riparian forest. Her results showed that the riparian grassland had the greatest GWP, but was only slightly more than the upland sites. The forested areas had the smallest GWP. However, carbon can be sequestered in riparian soils if the conditions are advantageous. This would occur when the conditions are right for the formation of soils that incorporate carbon into the soil matrix so it is available for plant use. If the rate of plant growth is large it is possible for the sequestration to exceed the carbon emitted as GHGs.

[3] A mole is a unit of measurement used to express an amount of chemical substance (i.e., 6.022×10^{23} molecules).
[4] GWP is the potential to retain infrared radiation in the atmosphere and contribute to the greenhouse effect over a specified time period (e.g., 100 years).

8.1.2 Temperature, Precipitation, and Runoff

Historical Climate

The historical climate of the Central Valley is characterized by hot, dry summers and cool, damp winters. The inland Mediterranean climate type of the Central Valley is a result of the topography and the strength and location of a semi-permanent, subtropical high-pressure cell. During summer, the Pacific high-pressure cell is centered over the northeastern Pacific Ocean resulting in stable meteorological conditions and a steady northwesterly wind flow. Cold ocean water upwells to the surface because of the northwesterly flow, producing a band of cold water off the California coast. In winter, the Pacific high-pressure cell weakens and shifts southward, resulting in wind flow offshore and allowing storm systems to move in from the Pacific Ocean.

Summer daytime temperatures can reach 90 degrees Fahrenheit (°F) with occasional heat waves bringing temperatures exceeding 115°F. Temperatures in the winter are often in the 50s, but lows in the 30s and 40s can occur on days with persistent fog and low cloudiness. In winter, temperatures below freezing may occur, but snow is rare in the valley lowlands and foothills. During the growing season, relative humidity is characteristically low; in the winter, humidity is usually moderate to high, and ground fog may form.

The majority of precipitation occurs from mid-autumn to mid-spring. The rare occurrence of precipitation during the summer is in the form of convective rain showers. The amount of precipitation in the Central Valley decreases from north to south primarily because the Pacific storm track often passes through the northern portion of the valley, while the southern portion remains protected by the Pacific high-pressure cell. Stockton, in the north, receives about 20 inches of precipitation per year, while Fresno, in the center, receives about 10 inches per year, and Bakersfield, at the southern end of the valley, receives less than 6 inches per year. Average annual rainfall is approximately 9.25 inches on the valley floor (SJVAPCD 2002).

The inter-annual variability of the Central Valley climate is strongly influenced by conditions occurring in the Pacific Ocean, including the El Nino Southern Oscillation and the existence of a semi-permanent high-pressure area in the northern Pacific Ocean. Although variable, the average mean-annual temperature has increased by approximately 2°F during the course of the 20th century for both the Sacramento River Basin and the San Joaquin River Basin.

Streamflow in the Sacramento River and San Joaquin River basins has also varied considerably from year to year and is varied geographically. Runoff is generally greater during the winter and spring months, with winter runoff generally originating from rainfall-runoff events and spring to early summer runoff generally supported by snowmelt from the Sierra Nevada. Historical changes in climate have resulted in declining spring runoff and a corresponding increase in winter runoff.

Future Projections

Climate change is a complex phenomenon that results in changes to several different aspects of the climate. One of the major impacts of climate change is an increase in average temperature. The average air temperature in the Project area and vicinity is projected to increase from almost 4°F to over 6°F by the end of the century (2070-2090 period) compared to the baseline conditions (1961-1990) (Cal-Adapt 2012). This increase in temperature is expected to result in changes in precipitation patterns. Depending upon the assumptions and climate models used for a particular study, both wetter and drier conditions have been projected (Brekke et al. 2004, Pacific Northwest Research Station 2005, PRBO Conservation Science 2011). Overall, Cal-Adapt projects a possible decrease in the average annual precipitation of 0 to 2 inches in the Project area and vicinity. Climate change may result in changes to the pattern of snowfall in the mountains above Friant Dam, leading to less overall water storage in the mountains. Cal-Adapt projects that the April snow water equivalent in the mountains above Friant Dam could decrease by 80 to 90 percent in the lower elevations and 30 to 40 percent at the upper elevations by the year 2100 (Cal-Adapt 2012b). This would result in less spring and summer runoff into Millerton Reservoir than at present.

Climate modeling groups have produced hundreds of simulations of past and future climates for the IPCC Fourth Assessment Report. The World Climate Research Programme Working Group on Coupled Modelling helped to coordinate these activities through the Coupled Model Intercomparison Project Phase 3. These model results were organized into a website hosted by the Lawrence Livermore National Laboratory (LLNL) and others (LLNL 2013). The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), working with others, generated gridded (1/8 degree [°] by 1/8°, latitude by longitude) climate projections using these data. These projections were developed through support from the Reclamation WaterSMART Basin Studies Program as part of the West-Wide Climate Risk Assessments activity (Reclamation 2011). These projections consist of 16 different Global Climate Models and three different CO_2 emission scenarios from the IPCC Fourth Assessment Report. For several of the projections, results were provided using different initial conditions for a total of 112 different projections (the results of climate projection modeling are sensitive to the initial conditions used in the models). From these climate projections potential changes in hydrology were computed for three future decades: 2020s (water years 2020 to 2029), 2050s (water years 2050 to 2059) and 2070 (water years 2070 to 2079) from the reference 1990s' decade (water years 1990 to 1999). The reference 1990s is from the ensemble of simulated historical hydroclimates, not from the observed 1990s data.

Future Runoff Projections

The gridded model output was used to estimate runoff from watersheds covering the major Reclamation basins and the Western United States (Reclamation 2011). Runoff results for the San Joaquin River at Friant Dam (Figure 8-2) show the change in total annual runoff into Millerton Reservoir relative to the total annual runoff in the 1990 decade. For the period 2010 to 2050 the total annual runoff is expected to decrease to about 90 to 95 percent of the 1990 decade. By the end of the century the total annual runoff is expected to decrease to between 75 to 80 percent of the 1990 decade. This analysis is based on the median projection from 112 model outputs (Reclamation 2011).

It should be noted that the variability between model results is large with the coefficient of variability (standard deviation divided by the mean) equal to about 1.

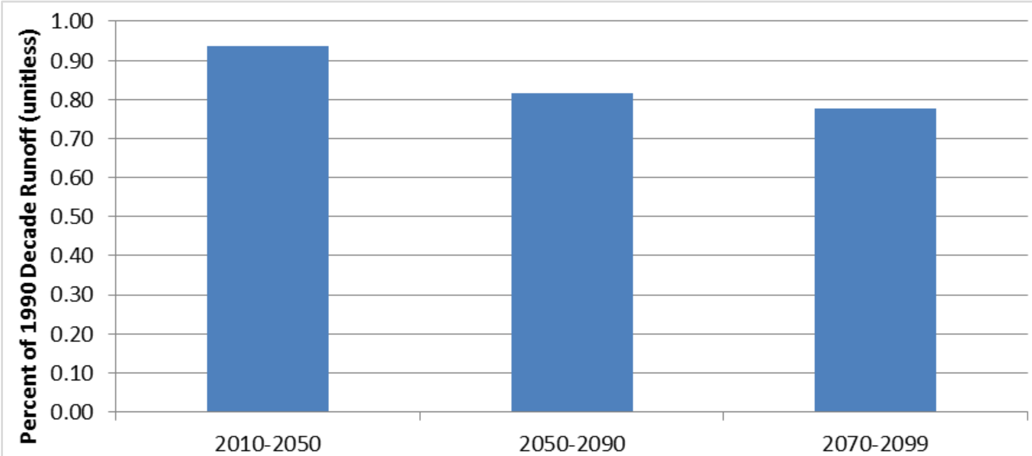

Figure 8-2.
Change in the Total Runoff into Millerton Reservoir Relative to 1990 Decade

In addition to the decrease in runoff, the timing of the runoff is expected to change. Figure 8-3 shows ensemble-median mean-monthly values (heavy lines) for the 1990s, 2020s, 2050s, and 2070s for the San Joaquin River at Friant Dam, and the decadal-spread of mean-monthly runoff for the 1990s (grey shaded area) and 2070s (magenta shaded area) where spread is bound by the ensemble's 5^{th} to 95^{th} percentile values for each month (the purple shaded area is where the spreads overlap). The spread shown in the figure does not represent the expected range in flows, but the uncertainty in the future projections. In general, in the future there would be more runoff in winter/spring (January to April) and less runoff in the summer (May to July). The change in inflows is small in the 2020 decade; the 2020 values are within the uncertainty of the 1990 and 2020 decades' data, so little effect would be expected on the timing of inflows during that period. By the 2070 decade, the results show a noticeable drop in runoff during the spring/summer period though there is a large uncertainty in the model predictions. Regardless, the operation of the larger dams in the San Joaquin River system, primarily Friant Dam, would determine the timing of summer flows in the San Joaquin River.

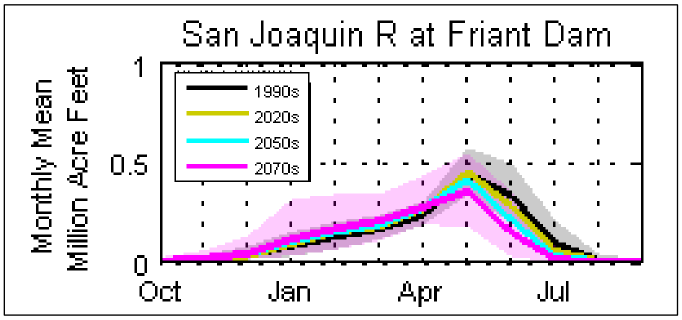

Figure 8-3.
Changes in Runoff to Friant Dam from 1990s to 2070s based on Analysis of 112 Different Combinations of Global Climate Models and Emission Scenarios

Future Water Temperature

The increase in air temperature due to climate change has the potential to increase water temperatures in the San Joaquin River. An estimate of the scale of the effect of increased air temperature on water temperature was made by estimating the equilibrium temperature of the water with and without climate change. The equilibrium temperature is the water temperature where there is zero net heat exchange between the water and its surroundings. If the meteorology conditions were constant for several days to a week or so, depending upon the depth of water and the meteorology, the river water temperature would eventually equal the equilibrium temperature. However, since the meteorology conditions are never constant, the water temperature tends to “chase” the equilibrium temperature, lagging its increase in the spring in summer as solar radiation and air temperature increases and in the fall and winter when solar radiation and air temperature decreases. The calculation of equilibrium temperature follows the procedures described in Bogan, Mohseni, and Stefan (2003) with the following assumptions:

- Cloud cover is zero.
- Wind speed is zero.
- No precipitation.
- Surface albedo = 0.31.

Figure 8-4 compares the equilibrium water temperature to measured water temperature in the San Joaquin River below the Chowchilla Bypass. Solar radiation and air temperature data for the calculation were obtained for the California Irrigation Management Information System (CIMIS) Station 7, Firebaugh/Telles (CIMIS 2013). Observed water temperature data were obtained for the California Data Exchange Center [CDEC] database for Station San Joaquin River below Bifurcation (SJB) (CDEC 2013). The observed water temperature lags the equilibrium temperature by 10 to 15 degrees centigrade (°C) (18 to 27°F), but can be almost 30°C (54°F) lower in the summer.

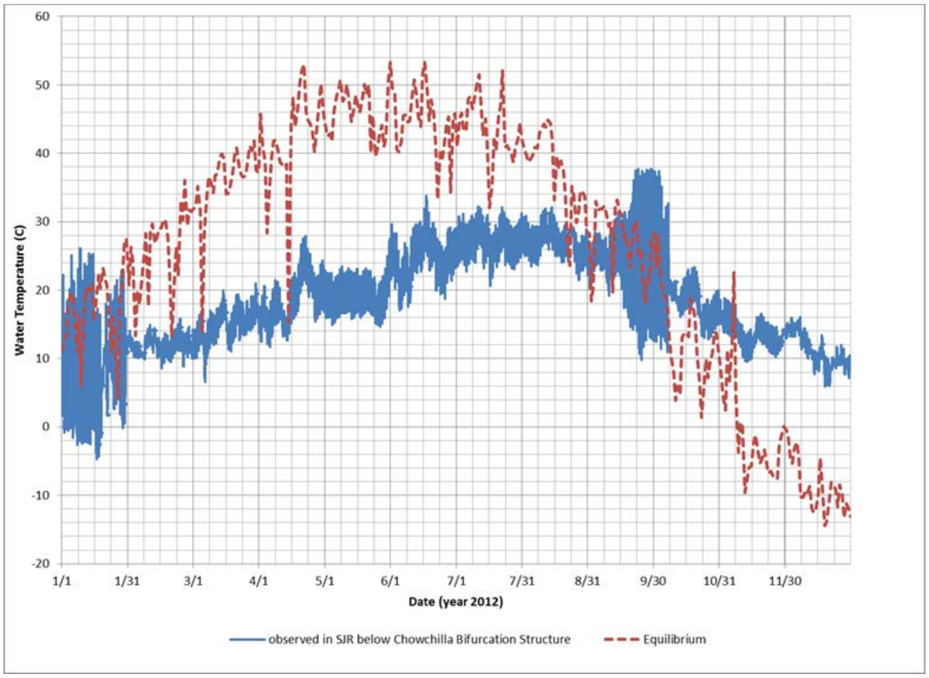

Figure 8-4.
Comparison between Measured and Equilibrium Water Temperatures in Reach 2B for Calendar Year 2012

Figure 8-5 shows the increase in equilibrium water temperature, using the same 2012 data described above, for the cases of a 2, 4 and 6°C (3.6, 7.2 and 10.8°F) increase in air temperature. In the winter the increase in equilibrium temperature is less than the increase in air temperature. However, in the summer the increase is greater indicating that summer water temperatures would be affected more than winter/spring water temperatures. This is driven by the increase in atmospheric long-wave radiation. Atmospheric radiation is modeled as a function of air temperature to the fourth power so increases in high air temperatures have a greater effect on water temperatures than increases in lower air temperatures. Note, that the actual increase in water temperature will likely be less than the increase in equilibrium temperatures shown in Figure 8-5 as the results shown in Figure 8-5 do not include cloud cover and wind speed which has the effect of lowering temperatures. Regardless, there is likely to be an increase in water temperature in Reach 2B due to climate change. The relative (to air temperature) increase will be small in the spring, but larger in the summer.

As the existing climate throughout California changes over time, the ranges of various plant, fish, and wildlife species could shift or be reduced, depending on the favored temperature and/or moisture regimes of each species. In the Project area, changes in vegetation, fish, and wildlife would depend, in part, upon water temperature, the amount of available water, and the available seed bank.

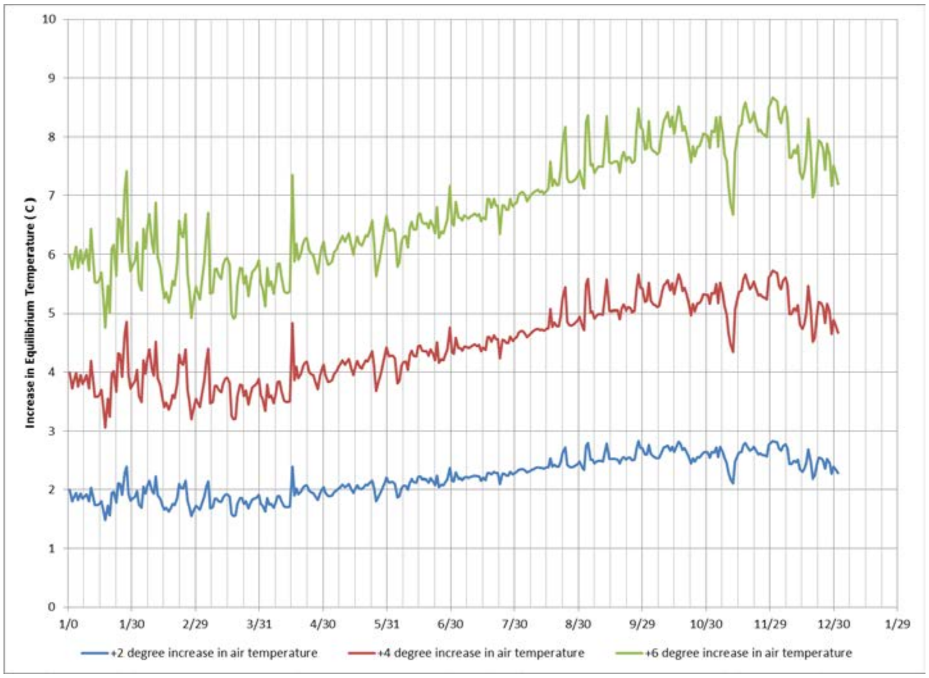

Figure 8-5.
Increase in Equilibrium Water Temperature for a Range of Increases in Air Temperature

8.1.3 San Joaquin River Restoration Program Actions

Climate change poses a threat to Reclamation's basic mission objectives, including both delivering quantities of water and sustaining environmental flows (Reclamation 2014a). In response, and as directed by both Section 9503 of the 2009 Secure Water Act and Secretarial Order No. 3289, Reclamation developed a Climate Impact Assessment for the Sacramento and San Joaquin River Basin and the Central Valley Project Integrated Resource Plan (Reclamation 2014b, 2014c). These reports and other studies provide climate change prediction for the Restoration Area and are integrated into the SJRRP's plans and actions.

Reclamation has developed climate change projections for four climate change scenarios that are representative of more than 100 discrete climate simulations and for a fifth "consensus scenario" that is an ensemble of the central tendency of temperature and precipitation. These climate predictions are for mid-century, with a date of 2055. Key conclusions of the climate change predictions include the following (Reclamation 2015):

- The consensus scenario predicts air temperatures in the basin to rise by 3.6° F (2.0° C), with the suite of four scenarios predicting a range from 1.8° to 4.7° F (1.0° to 2.6° C).
- The consensus scenario predicts runoff in the basin to decline by 6 percent, with a suite of four scenarios predicting a range from +25 percent to -31 percent.

- The consensus scenario predicts that reduction in runoff will be primarily from reduced number of “Normal-wet” years in favor of “Normal-dry” years. The proportion of “Dry”, “Critical-high” and “Critical-low” water year types are predicted to remain relatively stable.
- All scenarios predict the timing of peak runoff to advance, occurring slightly earlier in the year.
- The deep cold pool in Millerton Lake is projected to decrease in volume by an average of 4 percent by mid-century. However, the thermal behavior of the reservoir is complex, with higher flows in wet years mixing deeper and reducing the cold pool, and low flows tending to reduce mixing and preserving the cold pool.
- San Joaquin River water temperatures at Gravelly Ford are predicted to increase in all scenarios due to the combined effects of changes in runoff and air temperature. Predictions range from 0.3° to 1.5° F (0.2° to 0.8° C) warmer during summer months by mid-century.

The SJRRP can implement a range of climate change adaptations. Some of the key findings and adaptive strategies that can be used are listed below (Reclamation 2015):

- Enhanced riparian vegetation can substantially lower water temperatures by several degrees, particularly if shading is increased over several miles of riverway. The SJRRP has evaluated shading scenarios in a calibrated and verified water temperature model for the San Joaquin River, finding that dense riparian vegetation shading can reduce summer temperatures by approximately 3° F.
- Altering the river geomorphology, principally by narrowing the low-water channel, can also have a beneficial impact upon water temperature. SJRRP modeling demonstrates that reducing channel width and increasing channel depth may reduce summer temperatures by 3° to 9° F.
- As flow has a substantial influence upon water temperature, increasing the flow rate during low flows is an effective way to reduce water temperatures, particularly in the upper reaches. The Restoration Administrator has flexibility with flow releases, including potential releases of banked Unreleased Restoration Flows, Buffer Flows, and adjusting the timing of spring and fall pulse flows to coincide with salmon migration timing.
- Earlier runoff as predicted by all climate models may benefit restoration efforts as it more closely coincides the timing of natural runoff with anticipated Restoration Flow releases. Additionally, earlier runoff may improve water year forecasting accuracy during the critical months of restoration flows.
- Isolating gravel pits along the upper reaches of the river would have a beneficial impact upon river water temperatures.
- Water temperature models as available on the San Joaquin River do not adequately characterize the thermal structure of deep pools in the river, which provide a refuge for fish during periods of warmer water temperatures. These

thermal refugia already exist in the San Joaquin River and bypasses and will improve fish survival during warmer periods.

- Fish temperature thresholds are generally protective of the full range of fish temperature tolerances, and thus a self-sustaining naturally reproducing population may be possible without meeting temperature thresholds during all migration windows. Fish temperature thresholds represent key aspects of their tolerances, and operate over a gradient – not an absolute number; critical temperatures do not mean all fish die, but that on average their survival decreases. Care should be given that these thresholds are not improperly interpreted in the face of climate change.
- Greater conservation of the Millerton cold pool is possible through installation of a selective withdrawal structure at the Friant Dam intake. Although this is not a part of the current San Joaquin River Restoration Program Framework, Friant Dam upgrades could be recommended as a Paragraph 12 project by the Restoration Administrator.

The Restoration Goal is to restore and maintain fish populations in “good condition” in the main stem San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish. SJRRP has a number of adaptive management strategies and tools in place to support this goal and to address rising water temperatures. Use of just a subset of these tools can reduce river temperatures during critical times to a greater degree than the river warming that is anticipated under mid-century climate change scenarios (approximately 1.5° F). SJRRP will manage water temperatures for all life stages of Chinook salmon. In some cases, especially during dry years, managing fish may entail moving them out of the river system prior to exceeding water temperature thresholds. Summer temperatures in the lower reaches will seldom be cool enough to support salmon, yet this is not a critical time and place for the fish and likely may not have been historically.

SJRRP’s fish population targets allow for a range of annual fish survival rates, tolerating low production years when balanced out by high production years. The reintroduction of fish and flows into the river will allow the Program to measure success, confirm modeling, and adapt to uncertain future influences such as climate change. There is nothing to date that would indicate current or future water temperatures would present a fatal flaw in the Program’s goals. The SJRRP understands the challenging nature of maintaining appropriate water temperatures and has put substantial effort into understanding its variability and cultivating management tools.

8.2 Regulatory Setting

8.2.1 Federal

Climate change and GHG emission reductions are a concern at the Federal level. Laws and regulations, as well as plans and policies, address global climate change issues. This section summarizes key Federal regulations relevant to the Project.

EPA Endangerment and Cause and Contribute Findings

On December 7, 2009, the EPA Administrator signed two distinct findings regarding GHGs under Section 202(a) of the Federal Clean Air Act (CAA):

- *Endangerment Finding:* the current and projected concentrations of the six key GHGs— CO_2, methane, N_2O, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride—in the atmosphere threaten the public health and welfare of current and future generations.
- *Cause or Contribute Finding:* the combined emissions of these well-mixed GHGs from new motor vehicles and new motor vehicle engines contribute to the GHG pollution, which threatens public health and welfare.

This endangerment finding was challenged and in *Massachusetts v. U.S. Environmental Protection Agency, et al*., 549 U.S. 497, the United States Supreme Court ruled that GHG does fit within the CAA's definition of a pollutant, and that the EPA has the authority to regulate GHG. Therefore, the endangerment finding by the EPA stands.

EPA Mandatory Greenhouse Gas Reporting Rule

On September 22, 2009, the EPA released its final GHG Reporting Rule. The reporting rule is a response to the Federal fiscal year 2008 Consolidated Appropriations Act (H.R. 2764; Public Law 110-161), that required the EPA to develop "… mandatory reporting of GHGs above appropriate thresholds in all sectors of the economy…." The reporting rule applies to most entities that emit 25,000 metric tons of CO_2e ($MTCO_2e$) or more per year. Since 2010, facility owners have been required to submit an annual GHG emissions report with detailed calculations of facility GHG emissions. The reporting rule also mandates recordkeeping and administrative requirements in order for the EPA to verify annual GHG emissions reports.

Council on Environmental Quality Guidance

On December 18, 2014, the White House Council on Environmental Quality (CEQ) released a revised draft guidance regarding the consideration of GHG and climate change impacts in National Environmental Policy Act (NEPA) documents for Federal actions (CEQ 2014). This guidance indicates that agencies should consider both the potential effects of a proposed action on climate change, as indicated by its estimated greenhouse gas emissions, and the implications of climate change for the environmental effects of a proposed action. The revised draft guidelines also include a presumptive threshold of 25,000 $MTCO_2e$ emissions from a proposed action to trigger a quantitative analysis. The CEQ has not established when GHG emissions are "significant" for NEPA purposes; rather, the ultimate determination of significance remains subject to agency practice for the consideration of context and intensity (CEQ 2014).

Executive Order 13514

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, signed on October 5, 2009, establishes "an integrated strategy towards sustainability in the Federal Government and makes reduction of GHG emissions a priority for Federal agencies." Federal fleets would reach this vision by reducing fleet GHG emissions through reduced petroleum consumption. In March 2011, the CEQ issued instructions for implementing climate change adaptation planning in accordance with EO 13514.

Department of the Interior Climate Change Policy

The Department of the Interior has established a climate change impacts policy, which provides the following guidance:

- Ensure that climate adaptation plans are grounded in the best available science and understanding of climate change risks, impacts, and vulnerabilities, incorporating traditional knowledge where available.
- Consider climate change when developing or revising management plans, setting priorities for scientific research and assessments, and making major investment decisions.
- Use well-defined and established approaches, as appropriate, for managing through uncertainty, including: (1) vulnerability assessments, (2) scenario planning, (3) adaptive management, and (4) other risk management or structured decision making approaches.

8.2.2 State of California

Various statewide initiatives to reduce the State's contribution to GHG emissions have raised awareness that, even though the various contributors to and consequences of global climate change are not yet fully understood, global climate change is under way, and there is a real potential for severe adverse environmental, social, and economic effects in the long term.

Executive Order S-3-05

Executive Order (EO) S-3-05, which was signed by Governor Schwarzenegger in 2005, proclaims that California is vulnerable to the impacts of climate change. It declares that increased temperatures could reduce the Sierra's snowpack, further exacerbate California's air quality problems, and potentially cause a rise in sea levels. To combat those concerns, the EO established total GHG emission targets. Specifically, emissions are to be reduced to the 2000 level by 2010, the 1990 level by 2020, and to 80 percent below the 1990 level by 2050.

The EO directed the Secretary of the California Environmental Protection Agency (Cal/EPA) to coordinate a multi-agency effort to reduce GHG emissions to the target levels. The Secretary will also submit biannual reports to the governor and State legislature describing: progress made toward reaching the emission targets, impacts of global warming on California's resources, and mitigation and adaptation plans to combat these impacts. To comply with the EO, the Secretary of the Cal/EPA created the California Climate Action Team made up of members from various State agencies and commissions. The California Climate Action Team released its first report in March 2006. The report proposed to achieve the targets by building on voluntary actions of California businesses, local governments, and the community, as well as through State incentive and regulatory programs. The latest of these reports, *Climate Action Team*

Report to Governor Schwarzenegger and the California Legislature, was published in December 2010 (Cal/EPA 2010).

As a result of the thorough scientific analysis collected in these biennial reports, the comprehensive Climate Adaptation Strategy was released in December 2009 after extensive interagency coordination and stakeholder input. The California Natural Resources Agency (CNRA), in coordination with other State agencies, has updated the 2009 California Climate Adaptation Strategy. The *Safeguarding California Plan* (CNRA 2014) augments previously identified strategies in light of advances in climate science and risk management options (see http://resources.ca.gov/climate/safeguarding/).

Executive Order B-30-15

EO B-30-15 was signed by Governor Brown in April 2015. This EO establishes a California greenhouse gas reduction target of 40 percent below 1990 levels by 2030. This target is in line with levels needed in the U.S. to limit global warming below 2 degrees Celsius and will also facilitate reaching the ultimate goal of reducing emissions 80 percent under 1990 levels by 2050. The EO also specifically addresses the need for climate adaptation and directs State government to:

- Incorporate climate change impacts into the State's Five-Year Infrastructure Plan.
- Update the Safeguarding California Plan - the state climate adaption strategy - to identify how climate change will affect California infrastructure and industry and what actions the state can take to reduce the risks posed by climate change.
- Factor climate change into State agencies' planning and investment decisions.
- Implement measures under existing agency and departmental authority to reduce greenhouse gas emissions.

The Global Warming Solutions Act of 2006

In 2006, California passed the California Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32; Health & Saf. Code, § 38500 et seq., or AB 32). AB 32 further details and puts into law the mid-term GHG emissions reduction target established in EO S-3-05 to reduce statewide GHG emissions to 1990 levels by 2020. AB 32 also identifies the ARB as the State agency responsible for the design and implementation of emissions limits, regulations, and other measures to meet the target.

The statute presents the schedule for each step of the regulatory development and implementation process. In accordance with the AB 32 statutory requirements, the ARB published a list of early-action GHG emissions reduction measures by June 30, 2007.

Prior to January 1, 2008, the ARB also identified the current level of GHG emissions by requiring statewide reporting and verification of GHG emissions from emitters and identified the 1990 levels of California GHG emissions. By January 1, 2010, the ARB adopted regulations to implement the early-action measures.

In December 2007, the ARB approved the 2020 emissions limit (1990 emissions level) of 427 million $MTCO_2e$ of GHGs. The 2020 target requires the reduction of 80 million

$MTCO_2e$, or approximately 16 percent below the State's projected "business-as-usual" 2020 emissions of 507 million $MTCO_2e$.

Also in December 2007, the ARB adopted mandatory reporting and verification regulations pursuant to AB 32. The regulations became effective January 1, 2009, with the first reports covering 2008 emissions; the regulations were updated in 2012, and the updates became effective in 2013. The mandatory reporting regulations require reporting for major facilities that generate more than 10,000 $MTCO_{2e}$ per year. The ARB has met all of the statutorily mandated deadlines for promulgation and adoption of regulations.

Scoping Plan

On December 11, 2008, pursuant to AB 32, the ARB adopted the Climate Change Scoping Plan (Scoping Plan). This plan outlines how emissions reductions would be achieved from significant sources of GHGs via regulations, market mechanisms, and other actions. Six key elements, outlined in the Scoping Plan, are identified below to achieve emissions reduction targets:

- Expanding and strengthening existing energy efficiency programs, including building and appliance standards.
- Achieving a statewide renewable energy goal of 33 percent.
- Developing a California cap-and-trade program that links with other Western Climate Initiative partner programs to create a regional market system.
- Establishing targets for transportation-related GHG emissions for regions throughout California, and pursuing policies and incentives to achieve those targets.
- Adopting and implementing measures pursuant to existing State laws and policies, including California's clean car standards, goods movement measures, and the Low Carbon Fuel Standard.
- Creating targeted fees, including a public goods charge on water use, fees on high global warming potential gases, and a fee to fund the administrative costs of the State's long-term commitment to AB 32 implementation.

The Scoping Plan also recommended 39 measures that were developed to reduce GHG emissions from key sources and activities while improving public health, promoting a cleaner environment, preserving our natural resources, and ensuring that the impacts of the reductions are equitable and do not disproportionately impact low-income and minority communities. These measures also put the State on a path to meet the long-term 2050 goal of reducing California's GHG emissions to 80 percent below 1990 levels.

To comply with AB 32 requirements for scoping plan updates, the ARB adopted the First Update to the AB 32 Scoping Plan in May 2014. The First Update defines the ARB's climate change priorities for the next 5 years and evaluates the alignment of long-term GHG reduction strategies with other State policy priorities areas.

8.2.3 Regional and Local

San Joaquin Valley Air Pollution Control District Guidance and Policy

The San Joaquin Air Pollution Control District (SJVAPCD) has established policies and guidance relating to GHG emissions from projects undergoing the California Environmental Quality Act Process (CEQA) process. On December 17, 2009, the SJVAPCD adopted the *Guidance for Valley Land-use Agencies in Addressing GHG Emission Impacts for New Projects under CEQA* to assist other lead agencies in establishing their own process for determining significance of project GHG impacts. The SJVAPCD also adopted the *District Policy – Addressing GHG Emission Impacts for Stationary Source Projects under CEQA when Serving as the Lead Agency* for its own use when serving as a lead agency. In support of the guidance document and policy, SJVAPCD also prepared a staff report, *Climate Change Action Plan: Addressing Greenhouse Gas Emissions under the California Environmental Quality Act*, which evaluates different approaches to assessing significance for GHG emission impacts (SJVAPCD 2009).

The guidance and policy rely on the use of performance based standards, otherwise known as Best Performance Standards, to assess significance of project specific GHG emissions on global climate change during the environmental review process, as required by CEQA. Lead agencies adopting this guidance as policy for addressing GHG impacts under CEQA would require that all projects with increased GHG emissions implement the Best Performance Standards, or otherwise demonstrate that project GHG emissions have been reduced by at least 29 percent from business-as-usual, to determine that a project would have a less than significant impact. The SJVAPCD has not established Best Performance Standards for construction or restoration projects.

8.3 Environmental Consequences and Mitigation Measures

8.3.1 Impact Assessment Methodology

This section focuses on the contribution of the Project alternatives to the buildup of GHGs in the atmosphere, which has been shown to contribute to climate change. It is unlikely that any single project by itself could have a significant impact on the environment with respect to GHGs. However, the cumulative effect of human activities has been clearly linked to quantifiable changes in the composition of the atmosphere, which has in turn been shown to be the main cause of global climate change.

The Project would emit GHGs from off-road construction equipment and worker vehicle trips associated with construction-related activities. Project operations would also result in GHG emissions, but only from worker vehicle trips to provide maintenance and operational support for the Project. The principal GHGs associated with the Project would be CO_2 and methane. The GHG emissions were quantified using the *Informal Guidance for California Department of Water Resources (DWR) Grantees: GHG Assessment for CEQA Purpose*.

Direct GHG emissions from construction equipment exhaust were estimated using the same models used for estimating criteria pollutant emissions (i.e., Roadway Construction Emissions Model [RoadMod], which incorporates ARB's In-Use Offroad 2011 Emission Inventory Model for off-road equipment and Emission Factors Modeling Software [EMFAC] for on-road mobile sources). These models only provide emission factors for CO_2 and methane. CO_2e emissions were estimated by multiplying the CO_2 and methane emission by their respective GWP factors. N_2O emissions are small and their exclusion has no material impact on the overall calculation of GHG emissions.

Indirect GHG emissions associated with electricity and water use are not quantified as these would be minimal compared to the amount of emissions from offroad equipment and onroad vehicles. At this time, there is not anticipated to be any substantial use of equipment powered by electricity for construction or operations.

GHG emissions associated with changes in carbon sequestration due to land use changes have been addressed in a qualitative manner for wetlands, discussing some of the anticipated outcomes based on evolving scientific studies, and a quantitative manner for growth of riparian habitat, based on ARB's estimates for carbon sequestration.

8.3.2 Significance Criteria

GHG Construction Threshold

As discussed previously, the SJVAPCD has provided guidance for evaluating significance of GHG emissions that is intended to assist lead agencies in addressing GHG impacts for CEQA purposes, but the determination of significant impacts are ultimately within the purview of the lead agency. The SJVAPCD guidance on assessing significance relies on Best Performance Standards and demonstration of GHG reductions compared to business as usual conditions. Best Performance Standards have not been established for construction projects.

As lead agency under CEQA, the CSLC evaluates projects on a case-by-case basis when determining whether or not project GHG impacts are significant. For this project, the CSLC recommends that construction GHG emissions be amortized over the life of the project (assumed to be equivalent to the 49-year lease period), and compared to a quantitative significance threshold of 10,000 $MTCO_2$e per year to determine the significance of project GHG impacts from construction. The CSLC developed this recommendation based on their consideration of several California Air Quality Management District (AQMD) and Air Pollution Control District (APCD) significance thresholds for large construction projects.[5]

For NEPA effects, the CEQ quantitative analysis trigger level of 25,000 $MTCO_2$e per year is a useful indicator for long-term actions with annual emissions, but a methodology

[5] There is no specific value used for a significance threshold among different air districts. For example, the South Coast Air Quality Management District uses the 10,000 $MTCO_{2e}$ per year threshold for significance, but the SJVAPCD only specifies a zero equivalency value (which is much smaller). Also note that some agencies use their own values, for example the DWR climate action plan specifies a 25,000 $MTCO_{2e}$ per year threshold for construction.

to evaluate short-term construction emissions is not provided. Therefore, the methodology and significance threshold used to determine CEQA significance of construction GHG emissions is also used to determine NEPA effects in this analysis.

GHG Operational Threshold

The SJVAPCD guidance on assessing significance relies on Best Performance Standards and demonstration of GHG reductions compared to business as usual conditions. Best Performance Standards have not been established for operations and maintenance of restoration projects.

The SJVAPCD has adopted a Zero Equivalency Policy for Greenhouse Gases, which establishes a level below which GHG emissions are considered equivalent to zero for SJVAPCD permitting purposes. GHG emissions of 230 $MTCO_2e$ per year or less are considered to be zero for SJVAPCD permitting purposes. The SJVAPCD has not adopted this level as a significance threshold, but rather as an approved GHG emissions level that would be considered equivalent to zero.

To determine NEPA effects associated with project operations, the annual operational emissions will be compared to the CEQ quantitative analysis trigger level of 25,000 $MTCO_2e$ per year.

8.3.3 Impacts and Mitigation Measures

This section provides a Project-level evaluation of direct and indirect effects of the Project Alternatives on climate change and GHG emissions. It includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. The analysis is organized by Project alternative with specific impact topics numbered sequentially under each alternative. With respect to climate change and GHG emissions, the environmental impact issues and concerns are:

1. Impacts from GHG Emissions Associated with Project Construction.
2. Impacts from GHG Emissions Associated with Project Operation.
3. Changes in Land Use that Result in a Net Change in GHG Emissions.

The following analysis considers the Project’s contribution to climate change and GHG emissions in the context of the cumulative condition. Other climate change and GHG emissions-related issues covered in the Program Environmental Impact Statement/Report (PEIS/R) (SJRRP 2011) are not covered here because they are programmatic in nature and/or are not relevant to the Project area.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the SJRRP would be implemented, including habitat restoration in other reaches, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, these Program-level activities would not achieve Settlement goals. This section describes the impacts of the No-Action

Alternative. The analysis is a comparison to existing conditions, and no mitigation is required for No-Action.

Impact CC-1 (No-Action Alternative): ***Impacts from GHG Emissions Associated with Project Construction*.** Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed. Therefore there would be no GHG emissions associated with construction of the Project. There would be **no impact**.

Impact CC-2 (No-Action Alternative): ***Impacts from GHG Emissions Associated with Project Operation*.** Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed. Therefore there would be no GHG emissions associated with operation of the Project. There would be **no impact**.

Impact CC-3 (No-Action Alternative): ***Changes in Land Use that Result in a Net Change in GHG Emissions*.** Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed. There would be no Project-related land use changes. Therefore, there would be **no impact.**

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities including a Compact Bypass channel, a levee system with a narrow floodplain encompassing the river channel, and the South Canal. Other key features include construction of the Mendota Pool dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure with fish passage facility and fish screens, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure of the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

Impact CC-1 (Alternative A): ***Impacts from GHG Emissions Associated with Project Construction*.** Compared to No-Action, Alternative A would directly emit GHG emissions as a result of construction activities associated with the Project. These direct emissions from offroad construction equipment and onroad vehicles were quantified. (Full details of the methodology used to quantify emissions are contained in Chapter 4.0, “Air Quality.” The construction offroad equipment schedule was provided by DWR.) GHG emissions associated with the operation of the equipment were estimated using statewide emission factors. Emissions associated with hauling of material to the Project area were estimated using EMFAC. Table 8-1 shows the GHG emissions associated with construction under each of the Action Alternatives.

As shown in Table 8-1, the amortized GHG emissions associated with construction of the Project is below the significance threshold of 10,000 $MTCO_2e$ per year under each alternative.

Furthermore, implementation of Mitigation Measures AQ-1A and AQ-1B to reduce criteria pollutant emissions from construction equipment and hauling trucks, respectively, could result in GHG emission co-benefits and further reduce GHG emissions below significance thresholds. The potential magnitude of these co-benefits would be highly depend on the specific measures applied, as well as the extent to which these measures are applied (e.g., the percentage of the equipment and vehicle fleet mitigated). For example, the use of alternative fuels such as liquefied natural gas (LNG) or compressed natural gas (CNG) in material hauling trucks could reduce GHG emissions by up to 14 percent compared to diesel (see Tables 8-2 and 8-3). If this strategy was applied to all material hauling truck activity during construction, total GHG emissions could be reduced by up to approximately 65,200 $MTCO_2e$.

Implementation of Mitigation Measure AQ-1C may also result in GHG reduction co-benefits through the funding of emissions reductions programs through a voluntary emissions reduction agreement with SJVAPCD, although any potential GHG co-benefit would be dependent on the type of reduction programs funded. As such, there is not enough information to estimate the potential magnitude of GHG reduction co-benefits from implementing Mitigation Measure AQ-1C (if any).

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Therefore, impacts from construction GHG emissions under Alternative A would be **less than significant**.

Table 8-1.
Total Project GHG Emissions

Year	$MTCO_2e$ per Year			
	Alternative A	Alternative B	Alternative C	Alternative D
Year 1	9,955	10,034	9,955	10,034
Year 2	30,390	30,518	30,390	30,518
Year 3	29,853	29,500	29,853	29,500
Year 4	25,611	27,837	25,611	27,837
Year 5	24,818	34,530	15,294	26,833
Year 6	72,809	67,323	47,319	47,319
Year 7	73,411	67,310	47,245	47,245
Year 8	73,097	66,997	46,587	46,587
Year 9	72,538	67,211	45,343	45,343
Year 10	65,690	49,541	NA	NA
Total $MTCO_2e$ Emissions	478,172	450,801	297,597	311,216
$MTCO_2e$ Emissions Amortized over Project Lifetime ($MTCO_2e$ per Year)	9,759	9,200	6,073	6,351

Notes: Amortized emissions assume a project life of 49 years (based on a 49-year lease period).
GHG = greenhouse gases
$MTCO_2e$ = metric tons of carbon dioxide equivalents

Table 8-2.
GHG Emissions from Fuel Combustion in Vehicles

Fuel Type	Fossil Carbon Intensity (gCO2e/MJ)	Energy Economy Ratio Adjustment for Vehicle Efficiencies	Adjusted Percent Reduction in Carbon Intensity Compared to Diesel
Diesel	74.9	1	--
Liquefied Natural Gas (LNG)	58.5	0.9	-13%
Compressed Natural Gas (CNG)	57.73	0.9	-14%

Source: California Air Resources Board 2009a, 2009b, 2012
GHG = greenhouse gases
gCO2e/MJ = grams of carbon dioxide equivalent per megajoule

Table 8-3.
Potential GHG Reductions from Use of CNG Trucks

Alternative	Total MTCO2e for Truck Trips	MTCO2e Reduction
Alternative A	454,395	-65,251
Alternative B	427,924	-61,449
Alternative C	275,441	-39,553
Alternative D	288,500	-41,428

Key:
CO2e = carbon dioxide equivalents
CNG = compressed natural gas
GHG = greenhouse gases
$MTCO_2e$ = metric tons of carbon dioxide equivalents

Impact CC-2 (Alternative A): *Impacts from GHG emissions Associated with Project Operation*. Compared to the No-Action, Alternative A would incur GHG emissions associated with routine maintenance and operations of the Project upon completion. Table 8-4 shows the GHG emissions associated with the operational phases of the Action Alternatives. The operational GHG emissions are less than 10 $MTCO_2e$ per year. These emissions are a conservative estimate because the GHG emissions in future years would decrease due to improvements in emissions from onroad vehicles. The operational GHG emissions under Alternative A would be below the CEQ analysis trigger level of 25,000 $MTCO_2e$ per year.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraph (i.e., the comparison of Alternative A to the No-Action Alternative). The operational GHG emissions for Alternative A would be less than the zero equivalency level of 230 $MTCO_2e$ per year. Therefore, GHG emissions associated with Project operation for Alternative A would be **less than significant**.

Table 8-4.
Total Operational GHG Emissions

Alternative	$MTCO_2e$ per Year
Alternative A	5.21
Alternative B	5.21
Alternative C	5.21
Alternative D	5.02

Notes:
$MTCO_2e$ = metric tons of carbon dioxide equivalents
GHG = greenhouse gases

Impact CC-3 (Alternative A): ***Changes in Land Use that Result in a Net Change in GHG Emissions.*** Compared to the No-Action Alternative, the Project would create new floodplain areas within Reach 2B. In the area where levees are set back, there would be a change in land use from agriculture to riparian and wetland. Although wetlands can act as both a source and a sink for GHGs, growth of riparian habitat can increase carbon sequestration and reduce total GHG emissions.

Managed agriculture can be a major source of N_2O emissions, a highly potent GHG. Wetlands can be a source of methane, a potent GHG, but they also can sequester carbon. Whether wetlands are a net source or sink of GHG depends upon many factors including the time frame of interest and the characteristics of the wetland.

Altor and Mitsch (2006) looked at how intermittent versus continuous inundation of a wetland affected methane production. Their study concluded that intermittently flooded wetlands emitted significantly less methane than continuously flooded wetlands when the wetland was allowed to dry between flood events. Importantly, they observed that intermittently flooded wetlands emitted less methane when they were flooded then wetlands that are always flooded. In Reach 2B, most wetland areas are expected to be intermittently flooded and therefore may not be significant producers of methane. In addition, wetlands would become net sinks for carbon over the long term.

According to habitat restoration estimates, Alternative A could provide up to 100 acres of valley foothill riparian habitat, 200 acres of riparian scrub, and 390 acres of willow scrub in the Project area (SJRRP 2012, Attachment A). Assuming that new growth of riparian or shrub habitat can sequester approximately 44.3 $MTCO_2e$ per acre over the long-term (e.g., 100 years) (ARB 2014b), Alternative A could provide up to a 31,000 $MTCO_2e$ reduction. Wetland and riparian zones would likely result in a substantial decrease in GHG emissions relative to continued managed agriculture over the long term.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). Therefore, compared to existing conditions, the Alternative A is expected to result in a **beneficial** effect.

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features including a Compact Bypass channel, a levee system with a wide, consensus-based floodplain encompassing the river channel, the Mendota Pool Control Structure, and the Compact Bypass Control Structure with fish passage facility and fish screens. Other key features include construction of a fish passage facility at the San Joaquin River control structure of Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass Control Structure), and removal of the San Mateo Avenue crossing. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

Impact CC-1 (Alternative B): *Impacts from GHG Emissions Associated with Project Construction*. Refer to Impact CC-1 (Alternative A). Potential construction impacts of Alternative B would be similar to the potential construction impacts of Alternative A except that the amortized GHG emissions associated with construction under Alternative B would be lower than Alternative A, as shown in Table 8-1. Construction GHG emissions under Alternative B would have a **less than significant** impact. Additionally, potential GHG emission reduction co-benefits from implementation of Mitigation Measures AQ-1A, AQ-1B, and AQ-1C would be similar to the potential co-benefits under Alternative A.

Impact CC-2 (Alternative B): *Impacts from GHG emissions Associated with Project Operation*. Refer to Impact CC-2 (Alternative A). Potential operational impacts of Alternative B would be similar to the potential operational impacts of Alternative A. There would be a **less than significant** impact.

Impact CC-3 (Alternative B): *Changes in Land Use that Result in a Net Change in GHG Emissions*. Refer to Impact CC-3 (Alternative A). Potential impacts of Alternative B would be similar to potential impacts of Alternative A. According to habitat restoration estimates, Alternative B could provide up to 340 acres of riparian scrub, 110 acres of valley foothill riparian habitat, and 500 acres of willow scrub in the Project area (SJRRP 2012, Attachment A). Assuming that new growth of riparian or shrub habitat can sequester approximately 44.3 MTCO2e per acre (ARB 2014b), Alternative B could provide up to a 42,000 MTCO2e reduction. This would result in a **beneficial** effect.

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Impact CC-1 (Alternative C): *Impacts from GHG Emissions Associated with Project Construction*. Refer to Impact CC-1 (Alternative A). Potential construction impacts of Alternative C would be similar to the potential construction impacts of Alternative A except that the amortized GHG emissions associated with construction under Alternative C would be lower than Alternative A, as shown in Table 8-1. Construction GHG emissions under Alternative C would have a **less than significant** impact. Additionally, potential GHG emission reduction co-benefits from implementation of Mitigation Measures AQ-1A, AQ-1B, and AQ-1C would be similar to the potential co-benefits under Alternative A.

Impact CC-2 (Alternative C): ***Impacts from GHG emissions Associated with Project Operation*****.** Refer to Impact CC-2 (Alternative A). Potential operational impacts of Alternative C would be similar to the potential operational impacts of Alternative A. There would be a **less than significant** impact.

Impact CC-3 (Alternative C): ***Changes in Land Use that Result in a Net Change in GHG Emissions*****.** Refer to Impact CC-3 (Alternative A). Potential impacts of Alternative C would be similar to potential impacts of Alternative A. According to habitat restoration estimates, Alternative C could provide up to 200 acres of riparian scrub, 100 acres of valley foothill riparian habitat, and 470 acres of willow scrub in the Project area (SJRRP 2012, Attachment A). Assuming that new growth of riparian or shrub habitat can sequester approximately 44.3 MTCO2e per acre (ARB 2014b), Alternative C could provide up to a 34,000 MTCO2e reduction. This would result in a **beneficial** effect.

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the North Canal bifurcation structure with fish passage facility and fish screens, removal of the San Joaquin River control structure of the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Impact CC-1 (Alternative D): ***Impacts from GHG Emissions Associated with Project Construction*****.** Refer to Impact CC-1 (Alternative A). Potential construction impacts of Alternative D would be similar to the potential construction impacts of Alternative A except that the amortized GHG emissions associated with construction under Alternative D would be lower than Alternative A, as shown in Table 8-1. Construction GHG emissions under Alternative D would have a **less than significant** impact. Additionally, potential GHG emission reduction co-benefits from implementation of Mitigation Measures AQ-1A, AQ-1B, and AQ-1C would be similar to the potential co-benefits under Alternative A.

Impact CC-2 (Alternative D): ***Impacts from GHG emissions Associated with Project Operation*****.** Refer to Impact CC-2 (Alternative A). Potential impacts of Alternative D would be similar to potential impacts of Alternative A. There would be a **less than significant** impact.

Impact CC-3 (Alternative D): ***Changes in Land Use that Result in a Net Change in GHG Emissions*****.** Refer to Impact CC-3 (Alternative A). Potential impacts of Alternative D would be similar to potential impacts of Alternative A. According to habitat restoration estimates, Alternative D could provide up to 340 acres of riparian scrub, 110 acres of valley foothill riparian habitat, and 580 acres of willow scrub in the Project area (SJRRP 2012, Attachment A). Assuming that new growth of riparian or shrub habitat can sequester approximately 44.3 MTCO2e per acre (ARB 2014b), Alternative D could provide up to a 45,000 MTCO2e reduction. This would result in a **beneficial** effect.

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9.0 Cultural Resources

This chapter describes the environmental and regulatory settings of cultural resources, as well as environmental consequences and mitigation, as they pertain to implementation of the Mendota Pool Bypass and Reach 2B Improvements Project (Project) alternatives. The discussion below includes descriptions of cultural resource conditions and the potential impacts of the Project alternatives on cultural resources for the area represented by the Project. The discussion in this section is supported by archaeological and historical architectural technical reports (Byrd et al. 2009) prepared for the Project, as well as for the Program Environmental Impact Statement/Report (PEIS/R) (SJRRP 2011), and the Native American ethnographic report (Davis-King 2009) prepared for the San Joaquin River Restoration Program (SJRRP). These reports are not publically available documents, as they contain confidential information on the location of sensitive cultural resources.

9.1 Environmental Setting

Cultural resources are defined as prehistoric and historic-era archaeological sites, Traditional Cultural Properties, Sites of Religious and Cultural Significance, and architectural properties (e.g., buildings, bridges, and structures). This definition includes historical properties as defined by the National Historic Preservation Act (NHPA). For the purposes of the discussion below, the term “Project area” refers to all areas that may be directly or indirectly affected by implementing Project actions. For the purposes of compliance with Section 106 of the NHPA, this area is identical to the “Area of Potential Effects” (APE).

A Programmatic Agreement (PA) is being developed among U.S. Department of the Interior, Bureau of Reclamation (Reclamation), the State Historic Preservation Office (SHPO) and consulting parties, including Native American Tribes, for compliance with Section 106 of the NHPA as it pertains to the Program. The PA would provide an overall framework for conducting the Section 106 process, including specific mitigation and review protocol, during the course of this Project as well as the entire SJRRP.

9.1.1 Regional Setting

The Project area lies within the central portion of the San Joaquin Valley, the southern extension of California’s Great Central Valley. The source of the San Joaquin River is along the crest of the high Sierra Nevada, between Yosemite and Kings Canyon national parks. The river descends through high glacial valleys and then steep canyons before it enters the Central Valley north of Fresno. The San Joaquin River is the southernmost drainage that typically flows north to the Sacramento-San Joaquin Delta and San Francisco Bay. In wet years, the Kings River and even the Kern River overflow Tulare and Buena Vista lakes, respectively, and flow northward to join the San Joaquin.

Elevation within the Project area is approximately 150 feet near Mendota Pool where the San Joaquin River turns and beings flowing northward (Byrd et al. 2009).

Geology and Geomorphology

The central area and eastern side of the San Joaquin Valley is dominated by a complex intermingling of basin deposits that dominate the valley floor, and large alluvial fans that issue from the foothills of the Sierra Nevada and extend across the valley. This geomorphic contact is a geologically and seismically active area, and this activity has had a direct effect on surface geomorphology, deposition, and soils.

Due to the dynamic nature of California's landscape, archaeological sites deposited over approximately the last 13,500 years (roughly the time that humans are known to have lived in California) have been subject to numerous geomorphic processes. These processes have buried, destroyed, or left these sites intact on the surface. Within the San Joaquin Valley, geomorphic processes include response of alluvial fan deposition to changing climate, fluctuating river courses and related floodplain deposition, response of lakes (e.g., Tulare, Buena Vista) to climate, and response of the San Joaquin River to sea-level rise and upstream effects of the formation of the San Joaquin Delta. All of these factors have likely affected the differential preservation of archaeological sites on the surface, which hampers efforts to accurately assess the effects of the Project solely through archaeological reconnaissance surveys that are necessarily limited to investigation of the modern ground surface.

In general, most Pleistocene-age landforms have little potential for harboring buried archaeological resources, as they developed prior to human migration into North America (ca. 13,500 years before the present [B.P.]). However, Pleistocene surfaces buried below younger Holocene deposits do have a potential for containing archaeological deposits. Holocene alluvial deposits may contain buried soils (paleosols) that represent periods of landform stability before renewed deposition. The identification of paleosols within Holocene-age landforms is of particular interest because they represent formerly stable surfaces that have a potential for preserving archaeological deposits. See Section 18.1 on paleontological resources that may be present in the Project area, which are, conversely, primarily limited to Pleistocene or older landforms.

Vegetation

Extensive marshes once surrounded the lakes, sloughs, and rivers of the San Joaquin Valley. Before the historic period, their size varied seasonally and episodically, depending on larger environmental trends. Plants such as tules (*Scirpus lacustris*), growing as tall as 10 to 12 feet, covered the entire range of the wetlands. On drier ground, vegetation consisted of sagebrush (*Artemesia* species), greasewood (*Purshia tridentate*), saltbush (*Atriplex* species), and various bunchgrasses. Few trees inhabited the area except for along river channels, and included cottonwood (*Populus fremontii*), sycamore (*Platanus racemosa*), and willow (*Salix* species). Wildlife abounded in the lake and marshlands where large numbers of migratory ducks and geese joined thousands of year-round aquatic birds. Freshwater mussel (*Margaritifera margaritifera*), fish, and turtles were abundant, along with pronghorn antelope (*Antilocapra americana*), tule elk (*Cervus elaphus*), and winter herds of mule deer (*Odocoileus hemionus*). The area was also home to plentiful numbers of rabbit (*Sylvilagus* species), black-tailed hare (*Lepus californicus*), and valley quail (*Lophortyx californica*) (Wallace 1978). The variety of wildlife in the San Joaquin Valley was typical for an area characterized by an arid to semi-arid climate, defined by hot summers and mild winters.

Cultural Setting

The following briefly discusses the archaeological record, the historical context, and the ethnographic context for the Project area. These contexts provide the basis for defining and ultimately evaluating any resources identified during the course of the investigation conducted for the purposes of this project.

Prehistoric Era

Prehistoric archaeological investigations have been limited within the San Joaquin River area of the Central Valley, and this area is considered by many to be one of the least understood regions in California with respect to prehistoric conditions (Moratto 1984, Riddell 2002, Rosenthal et al. 2007). As a result, archaeologists working in this area have been forced to borrow chronologies from nearby areas, particularly the foothills to the west (the eastern foothills of the Diablo Range) and to the east (the western slope of the Sierra Nevada) (Olsen and Payen 1969). These investigations of the western Sierra Nevada foothills have resulted in the formulation of local chronologies, notably the Chowchilla River/Buchanan Reservoir sequence.

Native American prehistoric occupation of the region began near the end of Pleistocene (circa 13,500 years ago) and continued until Spanish contact (in the late 1700s) (Rosenthal et al. 2007). Terminal Pleistocene (13,500 to 11,600 years ago) occupation in the region is represented by wide-ranging, mobile hunters and gatherers who periodically exploited large game. Throughout California, the prehistoric conditions of the Terminal Pleistocene are minimally represented and poorly understood. However, there is a probable Terminal Pleistocene site near Tulare Lake at the southern end of the Central Valley, and isolated artifacts dating to this era have been recovered within this area (Moratto 1984:81-82, Riddell and Olsen 1969).

Evidence of early Holocene (11,600 to 7,700 years ago) human settlement is only rarely encountered in the Central Valley (Rosenthal et al. 2007). Infrequent early Holocene sites in the foothills appear to have been seasonally occupied and include a robust ground stone assemblage focused on the processing of nuts. The lack of documented Central Valley early Holocene sites is undoubtedly due to sedimentation that has buried paleosurfaces of the time period (Rosenthal and Meyer 2004).

In the foothills, middle Holocene (7,700 to 3,800 years ago) sites are dominated by expedient cobble tools, likely used for various purposes including grinding, chopping, and pounding. Preserved plant remains from these sites are mainly represented by acorns and pine nuts. As with early Holocene sites, the relative lack of middle Holocene evidence in the Central Valley is due in large part to the archaeological record being buried by later sedimentation. Well-dated sites of this age in the Central Valley are typically discovered in buried contexts.

By 4,500 years ago, distinctive lowland and upland adaptive patterns emerged in the region (Rosenthal et al. 2007). Throughout the late Holocene (after 3,800 years ago) the Central Valley was characterized by a complex socioeconomic strategy focused on riverine and marsh resources and extremely elaborate material culture (Moratto 1984). Notable attributes included dart points, mortars and pestles; use of acorns and pine nuts; new fishing technologies and extensive exploitation of fisheries; basketry and cordage; ceramic items; diverse personal paraphernalia of stone, bone and shell; and large, formal cemetery areas.

Around 2,300 years ago, large populations began concentrating in major settlements along the San Joaquin River. Material culture included large dart points, mortars and pestles, milling stones, and bone spear points. Subsistence was concentrated on hunting and fishing and, based on secondary evidence, included hard seeds, with more limited use of acorns. Wide-ranging trade networks are documented and a non-egalitarian social organization and ascribed status may have emerged. With extended occupation at key settlements, large mounded villages were created. By approximately 1,000 years ago, population density had increased significantly, with noted developments in material culture including bow and arrow technology and new types of items of personal adornment.

Native Peoples at the Time of European Contact

At the time of contact with European settlers, the Project area was occupied by the Northern Valley Yokuts, who had lived in the region for some 4,500 years (Kroeber 1925; Latta 1977; Powers 1877; Wallace 1978). The Yokuts were hunter-gatherers who divided themselves into named tribes, each with a dialect, territory, and discrete settlements. Each tribe was politically autonomous and occupied a permanent area, usually on high ground along a major drainage course. The San Joaquin River and its main eastern tributaries formed the core of the Northern Valley Yokuts' homeland. Settlements west of the river tended to be in the foothills, concentrated along watercourses.

According to fragmentary information, the Yokuts exploited local subsistence resources from principal villages located on or near the San Joaquin River and other major streams (Cook 1955, 1960; Wallace 1978). Villages were composed of large, semisubterranean, round or oval dwellings. Some of the more major establishments also included larger communal dance houses. These villages were supported to a large extent by the riverine resources and by a variety of terrestrial plants, most importantly, oak trees for their acorns. Occupation was essentially sedentary, with dispersals occurring only seasonally for the acquisition of particular resources (Wallace 1978). Trade was focused along the river, where tule rafts were used for transportation. The Yokuts reportedly traded dogs to their Miwok neighbors in exchange for baskets and blankets. They acquired abalone and mussel shells from the coast and obsidian from the eastern slope of the Sierra Nevada.

Yokut populations at the time of Spanish contact have been estimated at about 41,000, with perhaps 5,000 living along the east side of the valley between the Merced and Kings rivers (Cook 1955). These numbers dropped drastically as native people here and throughout California were decimated by European and Euro-American diseases in the early 19th century and by the tremendous influx of nonnative people during the local gold-mining period from the mid-19th and into the 20th centuries (Wallace 1978). Today there are still several bands of Yokuts Indians living in the San Joaquin Valley, though none are known to practice the traditional, pre-contact way of life.

Historic Era

For some time only sporadic interaction took place between Native Californians and Europeans (Beck and Haase 1974, Clough and Secrest 1984, Hayes 2007). The first Spanish expedition into the San Joaquin Valley was led by Pedro Fages in 1772 who sought a new route between San Diego and Monterey. In the 1820s, the objective of inland expeditions had changed from scouting new mission sites to punitive forays against the San Joaquin Valley Indians, both Yokuts and Miwoks. The Indians had engaged in sorties on missions, towns, and ranchos to steal livestock for food and transportation since the early 1800s. A cycle of raids and reprisals across the coastal mountains continued until American settlers took up permanent residence in the valley in the mid-1840s (Beck and Haase 1974, Broadbent 1974, Cook 1976).

While Mexican troops engaged in punitive expeditions against the San Joaquin Valley tribes, American trappers and explorers made their first journeys into the region. The first was Jedediah S. Smith in 1827. Other trappers from the Hudson's Bay Company passed through the Central Valley, as well as Kit Carson and Peter Ogden Skene. Perhaps the most famous explorer in the region at this time was John C. Fremont who was in the vicinity in 1844 (Clough and Secrest 1984, Fremont 1852, Smith 1977). Fremont also remarked on the abundance of wild horses on the west side of the San Joaquin River, and the difficulty of travel because of the swampy terrain and sloughs.

Two small Spanish settlements developed in the Project area near Fresno Slough in the early decades of the 1800s, called *Pueblo de Las Juntas* and *Rancho de los Californios* (California Ranch) (Clough and Secrest 1984, Wallace 1978). Officially sanctioned colonial settlement of the San Joaquin Valley began in the 1840s when the Mexican government issued its first land grants to individuals who petitioned for land. Two Mexican ranchos were successfully patented at the northwest end of the Project area on the west side of the San Joaquin River (Rancho Sanjon de Santa Rita and Orestimba Rancho), and a third claim in the foothills near Friant was rejected (Rancho Rio del San Joaquin).

In response to the gold rush, Americans quickly built a line of towns and roadside stations north and south across the 250-mile floor of the San Joaquin Valley, with Stockton as the central distributing point (Moehring 2004). The few towns in the Project area established during the second half of the nineteenth century all have their origins as favorable places to cross the San Joaquin River. A few were later sustained by agriculture or industry. For example, the settlement at the current site of Friant, on the San Joaquin River just below the Friant Dam, began as a ferry crossing on the San Joaquin River around 1854. Beginning in the early 20th century, gravel mining emerged as a major industry in the vicinity of Friant; several companies opened mines and the town benefitted economically. Boom times came with the construction of Friant Dam in the 1940s and gravel mines have continued to operate into recent years.

During the 1870s, the Central Pacific Railroad, and later the Southern Pacific Railroad, spawned a network of some 50 railroad stations, of which 24 became railroad town sites. About eight of these town sites became strategic trading centers stretching from Stockton south to Bakersfield; among them were towns in and near the Project area at Merced (1871), Sycamore (1872), and Fresno (1872). The modern day town of Herndon, about 10 miles northwest of downtown Fresno on the banks of the San Joaquin River, was originally known as Sycamore and had its start as a railroad station stop on Southern Pacific's rail line along the east side of the San Joaquin Valley. Other early settlements emerged in the Central Valley more as a consequence of the Stockton-Los Angeles Road and Butterfield Overland Stage Company line, which ran between the major urban centers of the state. For example, the town of Firebaugh to the north of the Project area on the San Joaquin River began in 1852 when a ferry was built at the site; it later had a toll road from the river crossing and a stage route also passed through Firebaugh.

Gold in the southern Sierra Nevada Foothills attracted the first large influx of settlers to what is now Madera, Merced, and Fresno counties beginning in 1849. Towns like Millerton, now under Millerton Lake, were established at this time. Soon thereafter, settlers began to occupy the eastern San Joaquin Valley in this area. These were luckless miners and newcomers who recognized the agricultural potential of the valley and the need for food in the mining camps. Numerous individuals purchased land and established ranches on the vast and largely vacant plains by the mid-1850s. Although private ranches of several hundred acres existed, much of the land was unreserved public domain and cattle grazed freely on an open range from the Sierra Nevada Foothills to the Coast Range.

Livestock ranching grew and prospered into the late 1860s. A large number of immigrants from the Ohio Valley and Missouri settled in the San Joaquin Valley during this era; many drove cattle with them across the plains from the Midwest. Along with their cattle, they brought with them the Anglo ranching traditions from the Midwest characterized by favoring European breeds, keeping fenced pastures, raising hay for winter feed, maintaining mixed herds of dairy cows and beef cattle, practicing selective breeding, and employing Anglo cowboys and ranch hands. Immigrants also established farms on the plains between the foothills and San Joaquin River lowlands where they primarily raised wheat during the 1860s and 1870s.

The need for water to irrigate the arid San Joaquin Valley became a priority for the economic development of Central Valley towns, especially those laid out along Southern Pacific's railroad track. In 1873, the California State Legislature passed a "No Fence Law," which established agriculture's dominance over ranching. By the late 1880s small-scale irrigated agriculture was in the ascendancy and irrigation companies, colonies, and districts were formed to help promote agriculture, for which the first canals were completed in the 1870s. Passage of the Wright Act in 1887 provided a legal mechanism for landowners to create public irrigation districts and finance major irrigation works to divert water from the major streams flowing west from the Sierra. Successful irrigation enterprises, including land colonies, in the Central Valley allowed specialty crop agriculture to flourish and redefined the region's economy (Tinkham 1923). While crops such as grapes continued to be common in the early 20th century, the small farm tradition established by the agricultural colonies began to fade.

Early agriculture on the lower part of the Project area was dominated by the huge cattle ranching operation conducted by Henry Miller and Charles Lux. Miller and Lux developed massive ranching and farming operations on their property along the San Joaquin River (downstream from Mendota), including 140,000 acres in Madera County, more than 150,000 acres in Fresno County, and more than 250,000 acres in Merced County. Miller and Lux also became owners of a host of related subsidiary businesses, including stores, banks, hotels, irrigation systems, and public utilities. Miller and Lux were also pioneers in making use of a large-scale industrial labor force employed in a rural and agricultural setting.

Some of the oldest and most important irrigation works constructed within the Project area were built west of the San Joaquin River in 1871. The central unit of this vast canal and ditch system, constructed by Miller and Lux, was the so-called “Main Canal” of the San Joaquin and Kings River Canal and Irrigation Company. The Main Canal was the first canal built in Fresno County and one of the earliest large irrigation canals in California (W.W. Elliot and Co. 1882). The Main Canal was unique in that it required large amounts of capital and engineering skill, and irrigated thousands of acres. Its construction and success contributed to the 19th century agricultural development on the west side of the San Joaquin Valley (Jackson et al. 1990, Harding 1960, Pisani 1984). Miller and Lux also built the Dos Palos and Temple Slough canals by 1882 from the west bank of the San Joaquin. Over time, canals became increasingly important and extensive.

Irrigation districts started in California after passage of the Wright Act in 1887, which allowed for public tax-supported and democratically controlled irrigation districts. Progressive legislation passed in 1911 through 1913 increased State supervision over district organization and financing and made investing in irrigation district bonds more attractive. Demand for agriculture products also grew around this time and remained high throughout World War I. These conditions contributed to a flurry of district formation in California and to the formation of the Fresno Irrigation District and the Madera Irrigation District.

The Central Valley Project (CVP) was devised by the State, and ultimately built by the Federal government, to resolve California’s chronic water shortage problem. Studies undertaken between 1927 and 1931 resulted in a plan calling for a vast system of canals, massive dams, and reservoirs throughout the state, including most of what became the CVP (Hundley 1992). In 1935, Reclamation was charged with construction of the CVP, which was completed in the early 1950s (Hundley 1992). Reclamation designed the CVP as five fundamental units, operating as an integrated system: Shasta Dam, the Delta-Mendota Canal (DMC), Friant Dam, the Madera and Friant-Kern canals, and the Contra Costa Canal. The core of the system involved the coordinated operation of the other four units for the purpose of delivering Sacramento River water to the arid San Joaquin Valley.

Other water-related projects also flourished in the 20th century. These include the San Joaquin Hatchery, which is situated 1 mile below the Friant Dam, and extensive levee construction to minimize flooding. Major levee construction efforts to minimize flooding along the lower San Joaquin River were related to statewide flood control efforts. In 1913, with formation of the Sacramento and San Joaquin Drainage District, the San Joaquin River and its tributaries also came under jurisdiction of a Federal flood control plan (Bonte 1931). Flood control works on the San Joaquin River in the Project area did not begin to take shape until after World War II when the California State Reclamation Board began purchasing easements and rights-of-way for large overflow areas along the San Joaquin River. In 1955, the State created the Lower San Joaquin Levee District, which acted as a liaison with the U.S. Army Corps of Engineers, the California State Reclamation Board, and California Department of Water Resources (DWR) regarding construction of the Lower San Joaquin River Flood Control Project. Important aspects of the Lower San Joaquin River Flood Control Project include the Chowchilla Bypass, the Eastside Bypass, and the Mariposa Bypass, all of which were completed by 1966 (California State Reclamation Board 1966).

Throughout the historic era, transportation was an important focus of infrastructure development. Over time, foot travel and transportation by horse or stage coach gave way to river, railroad, and ultimately automobile travel. In the early decades of the 20th century the popularity of the automobile led to road improvements and a new State road building program. The main arterial along the eastside of the valley became the Golden State Highway in 1913 and then State Route 99.

9.1.2 Resources in the Project Area

The results presented below are adapted from the *Historic Properties Survey Report, Mendota Pool Bypass and Reach 2B Improvements Project* (Reclamation 2011).

Record Search and Surveys

To establish to what extent the Project footprint has been previously inventoried and what previously recorded resources exist within the areas that might be affected by the individual Project options and the alternatives for the Project, three record searches were conducted: November 2009 (RS#09-439), December 2009 (RS#09-479), and April 2010 (RS#10-173).

All of the literature searches were performed by the South San Joaquin Valley Information Center. The information center staff accessed the records for the Mendota, Firebaugh, and Tranquility U.S. Geological Survey 7.5-minute quadrangles, including a 1-mile radius around the Project footprint. The following references were also reviewed:

- National Register of Historic Places (NRHP) (2010).
- California Register of Historical Resources (CRHR) (2010).
- Office for Historic Preservation Historic Property Directory.
- California State Historical Landmarks (1996 and updates).
- California Inventory of Historic Resources (1976 and updates).

- California Points of Historical Interest (1992 and updates).
- California Department of Transportation's State and Local Bridge Survey (1986 and updates).
- Historical maps, including General Land Office Plat Maps.

In addition to the above references, the recently prepared sensitivity study for the entire SJRRP, *Cultural Resources Sensitivity Study and Research Design for the San Joaquin River Restoration Program, Fresno, Madera, Merced, and Stanislaus Counties, California* (Byrd et al. 2009), was also reviewed given its use in the preparation of the PEIS/R (SJRRP 2011) and its extensive information related to establishing the geoarchaeological[1] sensitivity and relevant cultural resource literature for the Project area.

Previous Survey Coverage

Each of the archaeological surveys reported by the Information Center, that are within or intersect the Project area, are small with respect to the actual acreage surveyed, and are all more than 5 years old, which tends to diminish their reliability (i.e., surveys greater than 5 years of age are typically viewed as dated and resurvey is required due to the potential for changed field conditions). The survey designation, year, and record search number are provided in Table 9-1. According to Byrd et al. (2009), only 6 percent of the area that represents Reach 2 has been previously surveyed. As a result, much of this region is not well known archaeologically.

In addition to the above reports, two recent studies have been conducted within the Project area. DWR prepared both reports in order to clear a proposed geotechnical analysis of potentially impacting unknown cultural resources. The surveys conducted in the vicinity of two of the proposed bore locations did identify cultural deposits potentially related to CA-FRE-45 and CA-FRE-106 (see below) (Gilbert 2011a; Gilbert 2011b). No additional evaluation of the deposits was conducted; however, all proposed geotechnical activities were moved to other locations to avoid potential impacts or effects to these deposits.

Table 9-1.
Previously Conducted Surveys within Project Area

Survey Designation	Year Accomplished	Records Search Number
FR 142	1997	RS#10-173
FR 148	1997	RS#09-439
FR 169	1969	RS#10-173
FR 265 (MA 108)	1998	RS#10-173
FR 388 (MA 897)	1980	RS#09-439
FR 775	1992	RS#09-439

[1] Geoarchaeology refers to the study of landscape change over time and the relative potential for archaeological sites to be either buried or destroyed by geomorphic processes.

Table 9-1.
Previously Conducted Surveys within Project Area

Survey Designation	Year Accomplished	Records Search Number
FR 2164	2004	RS#10-173
FR 2200	2005	RS#10-173
MA 48	1997	RS#10-173
MA 49	1997	RS#10-173
MA 116	1975	RS#09-439
MA 119 (FR 804)	1988	RS#10-173
MA 302	1982	RS#10-173
MA 331	1995	RS#10-173
MA 915	2002	RS#09-439

Key:
Survey Designation: FR= Fresno County; MA = Madera County
RS# = record search number;

Previously Recorded Cultural Resources

The previously recorded resources are tabulated in Table 9-2. Prior studies have led to the recording of six resources within the Project area. These include four archaeological sites, Mendota Dam, and a portion of Columbia Canal. Two of the known archaeological sites are located within the proposed river floodplain, one site is located within a potential borrow area, and one site is a generalized location approximately 2 square miles that has minimal overlap with the southeastern end of the Project area.

Table 9-2.
Previously Recorded Cultural Resources within Project Area

Site	Primary Number	Year Recorded	Site Type	Record Search Number
CA-FRE-45	P-10-000045	6/18/1939	Prehistoric	RS#10-173
CA-FRE-106	P-10-000106	2/1/1952	Prehistoric	RS#10-173
CA-FRE-563	P-10-000563	1/16/1975	Prehistoric	RS#09-439, RS#10-173
CA-MAD-301[1]	P-20-000301[1]	2/2/1975	Prehistoric	RS#09-439
Mendota Dam	P-10-003200	10/2/1997	Dam	RS#10-173
Columbia Canal	P-20-002383	12/11/2000	Canal	RS#09-439, RS#09-479

Notes:
[1] "Site" was recorded on the basis of hearsay; no field verification is represented in the site record.

With the exception of the Mendota Dam, the record searches did not identify any previously recorded resources that were previously determined eligible for the NRHP or CRHR. The prehistoric sites identified in the records search are predominantly old recordings of what were likely large habitation sites, but, even at the time of recordation, the majority of the site material had been heavily disturbed by some combination of development, farming, or alluvial processes.

Native American Communication

Information received from the Native American Heritage Commission on December 9, 2009, and December 23, 2009, indicates that no information pertaining to Native American cultural resources within the Project area was found in a review of the sacred lands file. The letters included a list of 14 individuals or organizations who should be contacted with regard to the proposed undertaking, and who may have information regarding cultural resources in the area. Letters were sent to each contact on November 30, 2010. One response has been received to date from Jerry Brown of the Chowchilla Tribe of Yokuts. Mr. Brown expressed interest in participating in any discussions regarding identified archaeological resources, if any.

Project-level Cultural Surveys

At the time of the cultural resources surveys in August 2010, access to privately owned property had been granted to only a portion of the Project area. Access had been granted primarily to parcels south of the San Joaquin River, and only limited access was available north of the river. The Project area represents about 5,360 acres. Due to the lack of access to much of the northern half of the Project area, as well as portions of the southern half, about 2,020 acres (38 percent) of the Project area has been subjected to survey to date. A team of four archaeologists conducted the survey using 20-meter transect intervals. Areas that were wet herbaceous habitat or seasonal wetland, especially within the North Loop oxbow (River Mile 207.7), were more cursorily surveyed due to a lack of surface visibility.

Archaeological Resources

With the exception of a single obsidian isolate, no archaeological resources were identified during the course of the surveys conducted for this EIS/R. The majority of the parcels were under some form of agriculture and therefore visibility of the surface varied from fair to good. The parcels were planted as orchards and vineyards, and consisted of riparian habitat along the banks of the river. None of the previously recorded prehistoric sites were relocated. In each case, the identified resource was described as almost destroyed or soon to be destroyed at the time of record. Furthermore, most of the sites were recorded over 40 years ago. Given the intensity of farming in the area, as well as a highly active riverine system nearby, an intact surface manifestation of cultural activity that was previously recorded is unlikely to have persisted to the present day. The isolated obsidian flake identified during field surveys for the current Project is likely a re-deposited artifact from one of the numerous sites located nearby and could lack any context to a known deposit or site.

Nevertheless, as indicated by Byrd et al. (2009) and SJRRP (2010), the potential for buried archaeological resources is high throughout the Project area. The alluvial environment near the San Joaquin River would generally have a high potential to contain buried archaeological sites. This is because large portions of the Central Valley are covered by Late Holocene landforms that include floodplain deposits laid down beginning about 4,000 years ago and continuing into the historic period. Even sites a few hundred years old may be buried (Gilbert 2011a, Byrd et al. 2009). Indeed, the subsurface analysis conducted by Gilbert (2011a; 2011b) suggested that at least two locations within the Project area may contain intact subsurface deposits associated with the recorded locations of CA-FRA-45 and CA-FRA-106.

Architectural Resources

An historical architecture survey and evaluation program was conducted for the Project area in 2010 by JRP Historical; the following results are summarized from this report (SJRRP 2010). This survey has included a field check of all previously evaluated resources, and the SJRRP has prepared the appropriate recordation documents, either as an update or as a new Department of Parks and Recreation 523 form, to verify current conditions and previous evaluations.

Table 9-3 below summarizes the historical architectural findings for those resources identified within the Project area and list their status codes, which describe their eligibility to the NRHP and/or CRHR (SJRRP 2010). Of the 13 built environment resources identified within the Project area, five have been previously evaluated for the NRHP. None of the other eight newly identified resources were found to be eligible for the NRHP or CRHR.

The Mendota Dam was determined eligible for the NRHP and is listed in the CRHR. Constructed in 1917, the Mendota Dam is significant, presumably at the State level, under Criterion A, for its association with the Miller and Lux Company's irrigation works in the Central Valley. The DMC appears individually eligible for the National Register (and California Register) under Criterion A, presumably at the State level of significance, within the context of development, construction, and operation of the CVP. The period of significance was identified from 1945 to 1951, its period of construction. Both the Mendota Dam and DMC are considered historic resources under the California Environmental Quality Act (CEQA).

Table 9-3.
Property Status Under the National Register and California Register

Name/Address	Year Built	County	APN	OHP Status Code
Properties Determined Eligible or Previously Found to Appear Eligible for the National Register and California Register				
Mendota Dam	1917	Fresno; Madera	N/A	2S2
Delta-Mendota Canal	1946-1951	Fresno	N/A	3S
Properties Determined Not Eligible for the National Register or California Register				
Columbia Canal and Ridge Ditch	ca. 1880s; 1891-1924	Madera	N/A	6Z, 6Y
Main Canal	1872	Fresno	N/A	6Z, 6Y
Outside Canal	1900	Fresno	N/A	6Z, 6Y
Properties that Appear Not Eligible for the National Register or California Register as a Result of the Current Study				
643 North San Mateo Avenue	ca. 1962-1970s	Fresno	013-040-25S	6Z
San Joaquin River and Fresno Slough Levees	1947-1955	Fresno; Madera	N/A	6Z

Table 9-3.
Property Status Under the National Register and California Register

Name/Address	Year Built	County	APN	OHP Status Code
Mowry Canal	ca. 1910	Fresno	N/A	6Z
Mowry Ranch	ca. 1950-1968	Fresno	013-020-28	6Z
3614-3618 Bass Avenue	1961-1965	Fresno	013-020-40	6Z
Helm Ditch	ca. 1899-1913	Fresno	N/A	6Z
Bass Avenue	1957-1961	Fresno	013-020-14ST	6Z
Main Firebaugh Canal (Intake Canal)	1919-1929	Fresno	N/A	6Z

APN = assessor's parcel number
ca. = circa
OHP = Office for Historic Preservation
N/A = not applicable
Status Code 2S2 = Individual property determined eligible for National Register by a consensus through Section 106 process. Listed in the California Register.
Status Code 3S = Appears eligible for National Register as an individual property through survey evaluation.
Status Code 6Y = Determined ineligible for National Register by consensus through Section 106 process – Not evaluated for California Register or Local Listing.
Status Code 6Z = Found ineligible for National Register, California Register or Local designation through survey evaluation.

9.2 Regulatory Setting

Under Federal and State law, effects to significant cultural resources (e.g., archaeological remains, historic-period structures, and traditional cultural properties) must be considered as part of the environmental analysis of a proposed project. Criteria for defining significant cultural resources are included in 36 Code of Federal Regulations (CFR) Part 63 (Determinations of Eligibility for Inclusion in the NRHP); the NHPA of 1966, as amended (16 United States Code [USC] 470 et seq.); and CEQA. In addition, 36 CFR 800 outlines the compliance process for Section 106 of the NHPA.

9.2.1 Federal

National Historic Preservation Act (36 CFR Part 800 Implementing Regulations Section 106)

The NHPA of 1966 is the primary Federal legislation which outlines the Federal government's responsibility to cultural resources. More specifically, Section 106 of the NHPA and its implementing regulations located at 36 CFR Part 800, outline the Federal government's responsibility in identifying and evaluating cultural resources. Other applicable Federal cultural resources laws and regulations that could apply include, but are not limited to, the Native American Graves Protection and Repatriation Act, and the Archaeological Resources Protection Act.

Section 106 of the NHPA requires the Federal government to take into account the effects of an undertaking on cultural resources listed on or eligible for listing on the NRHP and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. Those resources that are on or eligible for inclusion in the NRHP are referred to as historic properties. The 36 CFR Part 800 regulations describe the Section 106 process. They outline the steps the Federal agency takes to identify cultural resources and the level of effect that the proposed undertaking will have on historic properties. An undertaking is defined as any "…project, activity or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including:

- Those carried out by or on behalf of the agency.
- Those carried out with federal assistance.
- Those requiring a federal permit, license, or approval.
- Those subject to state or local regulation administered pursuant to a delegation or approval by a Federal agency [Section 301(7) 16 USC 470w(7)]."

It is the initiating of an undertaking that begins the Section 106 process. Once an undertaking is initiated the Federal agency must first determine if the action is the type of action that has the potential to affect historic properties. If the action is the type of action that has the potential to affect historic properties, the Federal agency must: 1) identify the area APE, 2) determine if historic properties are present within that APE, 3) determine the effect that the undertaking will have on historic properties, and 4) consult with the SHPO to seek concurrence on Federal agencies findings. In addition, the Federal agency is required through the Section 106 process to consult with Indian Tribes concerning the identification of sites of religious or cultural significance, and to consult with individuals or groups who are entitled to be consulting parties or have requested to be consulting parties. If the undertaking will result in adverse effects to historic properties, these adverse effects must be resolved in consultation with the SHPO and other parties identified during the Section 106 process before the undertaking can proceed to implementation.

Historical significance is assessed by applying the NRHP criteria as defined by 36 CFR Part 60.4. Historic properties need to possess both historical significance and integrity to be considered eligible for inclusion in the NRHP. If a property has historical significance but does not retain sufficient integrity, the property will not be considered eligible for inclusion in the NRHP. Conversely, if a property has maintained a high degree of integrity but has no historical significance, then it will also not be considered a historic property.

NRHP guidelines describe historical significance as the "quality of significance in American history, architecture, archeology, engineering and culture" that is "present in districts, sites, buildings, structures, and objects." Properties eligible for the NRHP can be significant on a national, state, or local level and must meet at least one of the following historical significance criteria:

- Criterion A: Properties that are associated with events that have made a significant contribution to the broad patterns of our history.
- Criterion B: Properties that are associated with the lives of persons significant in our past.
- Criterion C: Properties that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.
- Criterion D: Properties that have yielded or may be likely to yield, information important in prehistory or history.

Integrity is determined by applying the seven aspects of integrity to the historic resource: location, design, setting, materials, workmanship, feeling, and association. A resource will possess several, if not most, of the seven aspects of integrity to convey the historical significance of the resource.

Section 101(d)(6)(A) of the NHPA allows properties of traditional religious and cultural importance to a Native American tribe to be determined eligible for NRHP inclusion. In addition, a broader range of Traditional Cultural Properties are also considered and may be determined eligible for or listed in the NRHP. Traditional Cultural Properties are places associated with the cultural practices or beliefs of a living community that are rooted in that community's history may be eligible because of their association with cultural practices or beliefs of living communities that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community. In the NRHP programs, "culture" is understood to mean the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community, be it an Indian tribe, a local ethnic group, or the nation as a whole.

Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (25 USC § 3001 to 3013, 43 CFR Part 10) sets provisions for the removal and inadvertent discovery of human remains and other cultural items on Federal and tribal lands. The Native American Graves Protection and Repatriation Act clarifies the ownership of human remains and sets forth a process for repatriation of human remains and associated funerary objects and sacred religious objects to the Native American tribes or tribes likely to be lineal descendants or culturally affiliated with the discovered remains or objects.

Archaeological Resources Protection Act

The Archaeological Resources Protection Act (16 USC § 470aa-mm) sets forth requirements that must be met before Federal authorities can issue a permit to excavate or remove any archeological resource on Federal or Indian lands. The curation requirements of artifacts, other materials excavated or removed, and the records related to the artifacts and materials are also described.

Executive Order 13007 (Indian Sacred Sites) and April 29, 1994, Executive Memorandum

EO 13007 requires that Federal agencies with land management responsibilities accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners. This EO further requires that those agencies avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies also must maintain the confidentiality of sacred sites. Other requirements stipulate that the agencies provide reasonable notice of proposed actions or land management policies that may restrict future access to or ceremonial use of sacred sites, or that may adversely affect the physical integrity of sacred sites. The agencies must comply with the April 29, 1994, executive memorandum, “Government-to-Government Relations with Native American Tribal Governments.”

Reclamation received information from Native American Heritage Commission about which Native American groups would be interested in Project actions. Reclamation mailed letters requesting their comments on November 30, 2010. Also, these Native American groups were notified of the public scoping meetings and are included in the distribution list for this EIS/R. Reaching out to Native American groups, including the groups that participated in scoping and review of this EIS/R, demonstrates that Reclamation has complied with EO 13007. If an Indian sacred site is encountered within the Project area, measures will be implemented to prevent any restriction of access or effect on the site’s physical integrity. Continued compliance with this EO would be demonstrated through implementation of mitigation measures, as needed.

9.2.2 State of California

Under CEQA, the lead agency must consider potential effects to important or unique cultural resources. While the language is somewhat different between NHPA and CEQA, the definitions of eligible properties and of adverse impacts are essentially the same. Evaluations under CEQA consider a resource’s potential eligibility for inclusion in the CRHR.

California Register of Historical Resources

California Public Resources Code section 5024.1 establishes the CRHR. The register lists all properties considered to be significant historical resources in the State. The CRHR includes all properties listed or determined eligible for listing on the NRHP, including properties evaluated under Section 106 of the NHPA. The criteria for listing are similar as those of the NRHP. CEQA section 21084.1 requires a finding of significance for substantial adverse changes to historical resources and defines the term “historical resources.” CEQA section 21083.2 and State CEQA Guidelines section 15064.5, subdivision (c) provide further definitions and guidance for archaeological sites and their treatment.

California Native American Graves Protection and Repatriation Act

The California Native American Graves Protection and Repatriation Act (Health & Saf. Code, § 8010 et seq.) establishes a State repatriation policy intent that is consistent with and facilitates implementation of the Federal Native American Graves Protection and Repatriation Act. The act strives to ensure that all California Indian human remains and cultural items are treated with dignity and respect, and encourages voluntary disclosure and return of remains and cultural items by publicly funded agencies in California.

Executive Order B-10-11

EO B-10-11 was signed by Governor Brown on September 9, 2011. This EO establishes the role and responsibilities of the Governor's Tribal Advisor and directs State agencies and departments under the Governor's executive control to communicate and consult with Federally recognized tribes, other California Native Americans, and representatives of tribal governments to provide meaningful input into the development of legislation, regulations, rules, and policies on matters that may affect tribal communities.

Assembly Bill 52

AB 52, signed on September 25, 2014, amends CEQA, creates a new category of environmental resources: "tribal cultural resources," and imposes new requirements for consultation for projects that may affect a tribal cultural resources (Public Resources Code sections 5097.94, 21073, 21074, 21080.3.1, 21080.3.2, 21082.3, 21083.09, 21084.2, and 21084.3).

9.2.3 Local and Regional

There are no known regional or local plans or policies related to cultural resources.

9.3 Environmental Consequences and Mitigation Measures

9.3.1 Impact Assessment Methodology

To assess impacts to cultural resources, historic properties and potential buried archaeological resources within the Project area were identified (see Section 9.1.4). A search for historic properties within the Project area was conducted (SJRRP 2010). This step was intended to provide a baseline for comparison to Project alternatives and to initiate the Section 106 process between Reclamation and SHPO. Cultural surveys were also conducted in the Project area using 20-meter transect intervals, where access to private- or publicly-owned property had been granted.

To assess impacts to identified cultural resources within the Project area, the construction and operation of the Project was evaluated relative to the identified historic properties and potential buried archaeological resources to determine the potential for adverse effects to those resources. For example, Project actions that require ground disturbance have the potential to cause adverse effects to archaeological resources and Project actions that cause physical destruction or visual setting alterations have the potential to cause adverse effects to the built environment.

9.3.2 Significance Criteria

Federal Criteria

National Environmental Policy Act
Pursuant to National Environmental Policy Act (NEPA) regulations (40 CFR 1500–1508), Project effects are evaluated based on the criteria of context and intensity. Context means the affected environment in which a proposed project occurs. The severity of the impact is examined in terms of the type, quality, and sensitivity of the resource involved; the location and extent of the impact; the duration of the impact (short- or long-term); and other considerations of context. Intensity means the degree or magnitude of a potential effect where the effect is determined to be negligible, moderate, or substantial.

Pursuant to NEPA, in considering whether an action may “significantly affect the quality of the human environment,” an agency must consider, among other things, the unique characteristics of the geographic area such as proximity to historic or cultural resources (40 CFR 1508.27, subd. [b][3]), and the degree to which the action may adversely affect districts, sites, linear features, landscapes, buildings, structures, or objects listed, or eligible for listing, in the NRHP or may cause loss or destruction of significant scientific, cultural, or historical resources (40 CFR 1508.27 subd. [b][8]).

National Historic Preservation Act (16 USC Section 470 et seq.)
The NHPA establishes the Federal government policy on historic preservation and the programs including the NRHP, through which this policy is implemented. Under the NHPA, significant cultural resources, referred to as historic properties, include any prehistoric or historic district, site, building, structure, object, or landscape included in, or eligible for inclusion in, the NRHP. Historic properties also include resources determined to be National Historic Landmarks, which are nationally significant historic places designated by the Secretary of the Interior because they possess exceptional value or quality in illustrating or interpreting United States heritage. A property is considered historically significant if it meets one of the NRHP criteria and retains sufficient historic integrity to convey its significance. This act also established the Advisory Council on Historic Preservation, an independent agency responsible for implementing Section 106 of NHPA by developing procedures to protect cultural resources included in, or eligible for inclusion in, the NRHP. Regulations are published in 36 CFR Part 60 and 63, and 36 CFR Part 800.

Section 106 affords the Advisory Council on Historic Preservation and SHPO, as well as other consulting parties, a reasonable opportunity to comment on any undertaking that would adversely affect historic properties listed in or eligible for NRHP listing.[2] SHPO administers the national historic preservation program at the State level, review NRHP nominations, maintain data on historic properties that have been identified but not yet nominated, and consult with Federal agencies during Section 106 review.

[2] Mitigation required under Section 106 has the potential to bring significant impacts to less than significant levels for NEPA/CEQA.

The NRHP uses the National Register eligibility criteria (36 CFR 60.4) to evaluate significance. The criteria for evaluation are as follows:

- Properties that are associated with events that have made a significant contribution to the broad patterns of our history.
- Properties that are associated with the lives of persons significant to our past.
- Properties that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master; or that possess high artistic values; or that represent a significant and distinguishable entity whose components may lack individual distinction.
- Properties that have yielded, or may be likely to yield, information important in prehistory or history.

Section 101(d)(6)(A) of the NHPA allows properties of traditional religious and cultural importance to a Native American tribe to be determined eligible for NRHP inclusion. In addition, a broader range of Traditional Cultural Properties are also considered and may be determined eligible for or listed in the NRHP. Traditional Cultural Properties are places associated with the cultural practices or beliefs of a living community that are rooted in that community's history may be eligible because of their association with cultural practices or beliefs of living communities that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community. In the NRHP programs, "culture" is understood to mean the traditions, beliefs, practices, lifeways, arts, crafts, and social institutions of any community, be it an Indian tribe, a local ethnic group, or the nation as a whole.

State Criteria

State CEQA Guidelines section 15064.5 provides specific guidance for determining the significance of impacts on historic and unique archaeological resources. Under CEQA, these resources are called historical resources whether they are of historic or prehistoric age. CEQA section 21084.1 defines historical resources as those listed, or eligible for listing, in the CRHR, or those listed in the historical register of a local jurisdiction (county or city). NRHP-listed historic properties located in California are considered historical resources for the purposes of CEQA and are also listed in the CRHR. The CRHR criteria for listing such resources are based on, and are very similar to, the NRHP criteria. CEQA section 21083.2 and State CEQA Guidelines section 15064.5, subdivision (c) provide further definitions and guidance for archaeological sites and their treatment. Section 15064.5 also prescribes a process and procedures for addressing the existence of, or probable likelihood, of Native American human remains, as well as the accidental discovery of any human remains within the Project area. This includes consultations with appropriate Native American tribes.

Guidelines for the implementation of CEQA define procedures, types of activities, persons, and public agencies required to comply with CEQA. CEQA section 21083.2 defines "unique archaeological resources" as "any archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
- It has a special and particular quality, such as being the oldest of its type or the best available example of its type.
- Is directly associated with a scientifically recognized important prehistoric or historic event."

CEQA section 21084.1 also further defines "adverse effect" on a historical resource as "a project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment." CEQA defines substantial adverse change in the significance of a resource as the physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the resource is materially impaired (State CEQA Guidelines, § 15064.5, subd. (b)(1)). The significance of a historical resource is considered to be materially impaired when a project demolishes or materially alters in an adverse manner those characteristics that convey its historical significance and that justify its inclusion on an historical resource list (State CEQA Guidelines, § 15064.5, subd. (b)(2)).

9.3.3 Impacts and Mitigation Measures

This section provides an evaluation of the long-term and temporary effects of the Project alternatives on cultural resources. It includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. With respect to cultural resources, the environmental impact issues and concerns are:

1. Effects on Archaeological Resources from Ground Disturbing Activities during Construction.
2. Effects on Historical Properties Listed or Eligible for Listing in the National or California Register.
3. Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.

Other cultural-related issues covered in the PEIS/R are not covered here because they are programmatic in nature and/or are not relevant to the Project area. These issues include disturbance or destruction of cultural resources around Millerton Lake and disturbance or destruction of cultural resources along the San Joaquin River downstream from the Merced River.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the SJRRP would be implemented, including habitat restoration, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, these Program-level activities would not achieve Settlement goals. The potential effects of the No-Action Alternative are described below.

The analysis is a comparison to existing conditions, and no mitigation is required for No-Action.

Impact CUL-1 (No-Action Alternative): ***Effects on Archaeological Resources from Ground Disturbing Activities during Construction.*** Similar to existing conditions, Project features would not be developed in the No-Action Alternative and therefore Project construction activities would not occur. There would be **no impact**.

Impact CUL-2 (No-Action Alternative): ***Effects on Historical Properties Listed or Eligible for Listing in the National or California Register.*** Mendota Dam was determined eligible for the NRHP and is listed in the CRHR, while DMC has been recommended as eligible to NRHP (see Section 9.1.2). Changes to Mendota Dam and the DMC as a result of the Project-level actions would not occur. There would be **no impact**.

Impact CUL-3 (No-Action Alternative): ***Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.*** Under the No-Action Alternative, operations would continue similar to current operations and increased flows. Maximum channel conveyance would be limited to the existing capacity in Reach 2B. Therefore, there would be no new types of impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). Archaeological sites within and immediately adjacent to the San Joaquin River would continue to be potentially impacted by Friant Dam releases and downstream diversions during ongoing operations under the No-Action Alternative. The scale of these events would continue to vary greatly interannually, with the most damage to resources occurring during occasional wet years with major flood events. Cultural resources outside of the existing levee alignment would continue to be potentially degraded by agricultural activities. This impact would be **potentially significant**. No mitigation is required for No-Action.

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would entail construction of Project facilities including a Compact Bypass channel, a new levee system encompassing the river channel with a narrow floodplain, and the South Canal. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure and fish passage facility, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

Impact CUL-1 (Alternative A): ***Effects on Archaeological Resources from Ground Disturbing Activities during Construction.*** Compared to the No-Action Alternative, archaeological sites could be subject to adverse effects during construction activities under Alternative A. Soil excavation or compaction resulting from the use of heavy machinery on the construction site itself or in staging areas may affect the integrity of artifact-bearing deposits associated with known and as-yet undiscovered archaeological sites. Project alternatives entail a large amount of soil “borrowing” (as described in

Chapter 2, Section 2.2.4) from areas surrounding the San Joaquin River, which is a sensitive area for archaeological resources, particularly for buried deposits.

Adverse effects could occur to known archaeological resources as a result of ground disturbing activities, including soil borrowing. Cultural resources surveys conducted in the Project area prior to geotechnical activities have revealed buried cultural deposits at CA-FRA-45 and CA-FRA-106 (Gilbert 2011a; Gilbert 2011b). These deposits have not been evaluated for NRHP or CRHR eligibility. Additional buried elements could exist in these locations.

Adverse effects could also occur near the river channel. The alluvial deposits adjacent to the river are considered highly sensitive for buried archaeological resources. Unknown or unrecorded archaeological resources that are not observable when conducting standard surface archaeological inspection may exist within the Project area. Construction-related ground disturbance in areas that could contain unknown archaeological resources could cause substantial adverse changes in the significance of historical resources, unique archaeological resources, or historic properties. Currently about 38 percent of the Project area has been inventoried for archaeological resources. It is estimated that a large number of cultural resources would be documented within this reach after full inventory efforts (Byrd et al. 2009).

Compared to existing conditions, Alternative A would result in greater impacts to cultural resources as described in the preceding paragraphs. Construction of the Project could result in possible substantial effects on known or unknown archaeological deposits from ground-disturbing construction operations associated with the Project. This would cause substantial adverse changes in the significance of an archaeological resource pursuant to the NHPA (36 CFR Part 800) and is therefore considered an adverse effect under Section 106. Construction-related ground disturbance in areas that could contain unknown historical resources or properties could cause adverse changes in the significance of archaeological resources pursuant to State CEQA Guidelines section 15064.5. This impact would be **potentially significant**.

Mitigation Measure CUL-1A (Alternative A): ***Comply with Section 106 of the NHPA or Equivalent.*** Reclamation will comply with Section 106 of the NHPA during subsequent site-specific studies as access is granted to the large area of unsurveyed lands within the Project area for which permission to enter was not granted. Reclamation must comply with Public Resources Code sections 5024 and 5024.5, which require Federal agencies to confer with SHPO before implementing any project with the potential to affect historical resources listed in or potentially eligible for inclusion in the NRHP or registered as or eligible for registration as a State historical landmark.

Site-specific environmental reviews will be conducted before all ground-disturbing activities. The following mitigation measures, consisting of inventory, evaluation, and treatment processes, will be conducted by Reclamation as part of the environmental reviews to ensure compliance with Section 106 of the NHPA or Public Resources Code sections 5024 and 5024.5, as applicable. Coordination will continue with the relevant Native American tribes in the area, as necessary to complete these compliance processes.

Implementation Action: Inventory, evaluation, and treatment processes will be implemented during subsequent site-specific studies and as access is granted. These measures include conducting cultural resources surveys of portions of the Project area that have not been surveyed, planning activities to avoid known cultural resources, evaluating the significance of resources that cannot be avoided, and developing treatment process for significant resources.

- *Conduct cultural resources surveys of portions of the Project area that have not been surveyed.* Before any ground disturbance takes place in the Project area (including areas of ancillary activities, such as staging areas and access routes), cultural resource surveys covering the Project area will be conducted to locate and record cultural resources. Where appropriate, subsurface discovery efforts also will be undertaken to identify buried archaeological sites.
- *Plan activities to avoid known cultural resources.* Before carrying out ground-disturbing activities, areas that have been delineated as containing cultural resources will be demarcated, and all ground-disturbing or related activities will be planned to avoid these areas.
- *Evaluate significance of resources that cannot be avoided.* If cultural resources cannot be avoided through careful planning of the activities associated with the Project, additional research or test excavation (as appropriate) will be undertaken to determine whether the resources are significant.
- *Develop treatment process to mitigate effects of Project upon significant resources.* Impacts on significant resources that cannot be avoided will be mitigated in a manner that is deemed appropriate for the particular resource. Mitigation for significant resources may include, but are not limited to, data recovery, public interpretation, performance of a Historic American Building Survey or Historic American Engineering Record, or preservation by other means.

Location: In Project areas with subsequent site-specific studies and where additional access is granted.

Effectiveness Criteria: Successful compliance with Section 106 of the NHPA or Public Resources Code sections 5024 and 5024.5, as applicable.

Responsible Agency: Reclamation.

Monitoring/Reporting Action: Reclamation would report to SHPO and the consulting parties.

Timing: Site-specific environmental reviews will be conducted prior to ground-disturbing activities. Coordination will continue with the relevant Native American tribes in the area, as necessary to complete compliance processes.

Mitigation Measure CUL-1B (Alternative A): ***Conduct Subsurface Testing and/or Archaeological Monitoring in Proximity to Identified Sites or Areas of Sensitivity.*** Ground-disturbing activities that have the potential to affect archaeological resources may occur in areas that have been identified as either the location of a known archaeological site, or in as an area known to be sensitive for the presence of buried cultural resources. Implementation of the following measures would reduce potential impacts to known archaeological sites and areas of sensitivity.

Implementation Action: Prior to Project implementation, subsurface geoarchaeological testing will be conducted in areas where ground-disturbing construction activities are proposed in native sediments/soils near known archaeological resources, as well as any areas of proposed disturbance in areas identified by Byrd et al. (2009) as having high or very high sensitivity for buried archaeological resources, in order to rule-out the presence of buried archaeological resources within the Project's areas of subsurface disturbance. If subsurface testing is determined not to be feasible and/or the results of testing are inconclusive, an archaeological monitor approved by Reclamation and/or CSLC staff will be present during all ground-disturbing activities in those same areas described above.

In the event that cultural resources are exposed during construction, the monitor will be empowered to temporarily halt activities in the immediate vicinity of the discovery while it is evaluated for significance. If, in consultation with interested parties, it is determined that the cultural resources exposed are significant archaeological resources, and if Project activities cannot feasibly avoid the resource, additional measures will be implemented (see Mitigation Measures CUL-1C and CUL-1D below). Where necessary, Reclamation will seek Native American input and consultation.

Location: Construction areas with ground-disturbing activities occurring in native sediments/soils near known archaeological resources, as well as any areas of proposed disturbance in areas determined to be highly or very highly sensitive for buried archaeological resources by Byrd et al. (2009) or a subsequent Project-specific geoarchaeological sensitivity analysis.

Effectiveness Criteria: Performance tracking of this mitigation measure is based upon successful implementation and the approval of the documentation by SHPO and appropriate consulting parties.

Responsible Agency: Reclamation.

Monitoring/Reporting Action: Geoarchaeological testing will occur prior to, and/or archaeological monitoring will occur during, specified ground-disturbing activities. Reclamation will report to SHPO and the consulting parties.

Timing: Geoarchaeological testing will occur prior to ground disturbing activities. Active archaeological monitoring, as necessary, will occur throughout the duration of these specific ground-disturbing activities.

Mitigation Measure CUL-1C (Alternative A): ***Halt Work in the Event of an Archaeological Discovery.*** If any cultural resources are discovered during ground-disturbing activities, all work in the immediate vicinity of the resources will be halted, and an archaeologist approved by Reclamation and/or CSLC staff will assess the significance of the find. If the discovery is determined to be significant, work may proceed on other parts of the Project area while avoidance or mitigation alternatives are being developed and carried out.

Implementation Action: Reclamation will prepare and implement an Archaeological Treatment Plan, which will be developed in coordination with interested parties. This plan will include an approach for addressing unanticipated discoveries and will detail the specific procedures to be followed if archaeological materials are found during construction.

Reclamation will notify California State Lands Commission (CSLC) staff if the find is a cultural resource on lands under the jurisdiction of the CSLC. Reclamation will comply with all applicable rules and regulations promulgated by CSLC with respect to cultural resources in submerged lands.

If human remains are encountered, Reclamation will comply with applicable laws and regulations regarding notification and disposition of the remains. If the coroner determines that the remains are Native American, the coroner would notify the Native American Heritage Commission under Health and Safety Code section 7050.5 and Reclamation and/or CSLC staff would ensure that the discovery is treated in accordance with the provisions of Public Resources Code section 5097.98, subdivisions (a)-(d).

If any find is determined to be significant, Reclamation and/or CSLC staff, the Project archaeologist, and interested parties will determine the appropriate avoidance measures. All significant cultural materials recovered will be—as necessary and at the discretion of the Project archaeologist and with input from Native American representatives—subject to scientific analysis, professional museum curation,[3] and documentation according to current professional standards. In considering any suggested mitigation proposed to mitigate impacts on historic properties, historical resources, or unique archaeological resources, a determination will be made on whether avoidance is feasible in light of factors such as the nature of the find, Project design, costs, and other considerations.

[3] Curation is management and care of collections according to standard professional practice, which may include inventorying, accessing, labeling, cataloging, identifying, evaluating, documenting, storing, maintaining, periodically inspecting, and/or conserving original collections.

If, in consultation with interested parties, it is determined that a significant archaeological resource is present and that the resource could be adversely affected, one of the following actions may be followed, as feasible:

- If prudent and feasible, redesign the Project to avoid any adverse effect on the significant archaeological resource.
- Implement Mitigation Measure CUL-1D, Intentional Site Burial for Site Preservation.
- Implement an archaeological data recovery program (ADRP). If the circumstances warrant an ADRP, a data recovery program will be conducted. The scope of the ADRP will be determined together with the Project archaeologist and interested parties. The archaeologist will prepare a draft ADRP, which would identify the scientific/historical research questions that are applicable to the expected resource, the data classes the resource is expected to possess, and how the expected data classes would address the applicable research questions. Destructive data recovery methods will not be applied to portions of the archaeological resources not impacted by the Project.

Location: Active construction areas during ground-disturbing activities.

Effectiveness Criteria: Performance tracking of this mitigation measure will be based on successful implementation and approval of documentation by SHPO and appropriate consulting parties.

Responsible Agency: Reclamation and CSLC.

Monitoring/Reporting Action: Reclamation and/or CSLC staff will report to SHPO and the consulting parties.

Timing: Mitigation will be ongoing over the construction timeframe.

Mitigation Measure CUL-1D (Alternative A): ***Plan an Intentional Site Burial Preservation in Place*****.** If Project engineering concludes that avoidance is not feasible, a process to determine whether the site can be preserved through intentional site burial will be considered. When complete avoidance is not possible, preservation-in-place is the preferred form of mitigation for a “historical resource of an archaeological nature” because it retains the relationships between artifact and context and may avoid conflicts with groups associated with the site, pursuant to Public Resources Code section 15126.4, subdivision (b)(3)(A). The process presented in overview here will be specified in detail in the Archaeological Treatment Plan.

Implementation Action: To intentionally bury a site, it will be necessary to conduct test excavations to determine the vertical and horizontal extent of the identified resources. If excavations have not yet been conducted for the purpose of evaluating the site for eligibility in accordance with section 106 of the NHPA, an archaeologist approved by Reclamation and/or CSLC staff will conduct a formal excavation of the site to delineate the site boundaries and to determine the site's eligibility for the CRHR or NRHP.

If the site is found to be eligible or potentially eligible, and if avoidance is not feasible, then consideration will be given to intentional site burial. The Project archaeologist will, in consultation with interested parties, delineate the site boundaries, and prepare and implement a design plan to dictate the conditions of the intentional site burial according to the recommendations discussed in the National Park Service Technical Brief Number 5, *Intentional Site Burial: A Technique to Protect Against Natural or Mechanical Loss* (Thorne 1991).

Among the requirements of an effective capping design, the mechanical process of burying the site must be designed in a manner that ensures that the site matrix is protected during the placement process. Preconstruction testing can be used to determine the construction equipment and fill material load limits that are allowable without causing compression or warpage of the artifact and feature components of the site.

If the preconstruction testing determines that compression or warpage of the site is probable and that site capping would not reduce effects to less-than-significant levels, additional mitigation, such as data recovery, would be necessary. Furthermore, if it is determined that the engineering requirements of the Project at the location of the site prohibit the effective avoidance of the site or if the surrounding conditions prohibit the protection or preservation of the archaeological components, data recovery may be the only feasible mitigation (see Mitigation Measure CUL-1C, above). In addition, Reclamation and/or CSLC staff will make provisions to monitor the site after the burial process is complete.

Location: Active construction areas in the event of an archaeological discovery where avoidance is not feasible and capping can be designed to effectively minimize Project effects to the discovery.

Effectiveness Criteria: Performance tracking of this mitigation measure will be based on successful implementation and the approval of the documentation by SHPO and appropriate consulting parties.

Responsible Agency: Reclamation and CSLC.

Monitoring/Reporting Action: Reclamation and/or CSLC staff will make provisions with the archaeologist to monitor the site after the burial process is complete. Reclamation and/or CSLC staff will report to SHPO and the consulting parties.

Timing: Mitigation will occur in the event of an archaeological discovery where avoidance is not feasible and would be ongoing over the construction timeframe.

Mitigation Measure CUL-1E (Alternative A): ***Avoid Soil Borrowing in the Vicinity of Known Archaeological Resources.*** Reclamation will design the Project soil borrowing activities to avoid adverse effect on known archaeological resources, to the extent feasible. Known archaeological resources will be delineated and avoided during construction. Mitigation Measures CUL-1B, CUL-1C, and CUL-1D will also be implemented, as needed.

> **Implementation Action:** If feasible, Reclamation will design the Project soil borrowing activities to avoid any adverse effect on known archaeological resources, such as CA-FRA-45 and CA-FRA-106, both of which are considered potentially significant historical resources. (Mitigation Measures CUL-1B, CUL-1C, and CUL-1D will also be implemented, as needed.) At least 90-days prior to proposed borrowing activities, an archaeologist approved by Reclamation and/or CSLC staff will determine the extent of known resource near borrow areas through a presence or absence testing program using augers or test pits. The Project archaeologist will then cordon the site boundaries in a manner that restricts construction equipment or personnel from entering the site.
>
> **Location:** Within the vicinity of known archaeological resources, including CA-FRA-45 and CA-FRA-106.
>
> **Effectiveness Criteria:** Avoidance of areas within delineated site boundaries.
>
> **Responsible Agency:** Reclamation and CSLC.
>
> **Monitoring/Reporting Action:** Reclamation and/or CSLC staff will report to SHPO and the consulting parties.
>
> **Timing:** At least 90-days prior to proposed borrowing activities.

Implementation of Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E would decrease impacts on archaeological resources. Impacts after mitigation would be **less than significant** for Alternative A.

Impact CUL-2 (Alternative A): ***Effects on Historic Properties Listed or Eligible for Listing in the National or California Register.*** Under Alternative A, Mendota Dam and the DMC would not be modified by Project construction activities. Operations of Mendota Dam and DMC would be similar to the No-Action Alternative because these facilities are operated to make water deliveries which would not be affected by Alternative A.

Compared to existing conditions, these historic properties would remain unchanged. This alternative would have **no impact** to historic properties or historical resources of the built environment (architectural resources) that are listed or eligible for listing in the National or California Register.

Impact CUL-3 (Alternative A): ***Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.*** Compared to the No-Action Alternative, the increased channel conveyance capacity, increased floodplain area, and floodplain and channel grading associated with Alternative A, in combination with flood flows and

Restoration Flows, could allow opportunities for new impacts to cultural resources (archaeological sites, historic-era structural resources, and traditional cultural properties/areas of concern). Alternative A would include a new levee system encompassing the river channel and additional floodplain areas that would typically have been disturbed by prior agricultural activities. Although there is a potential for increased erosion on the floodplain due to flood flows and Restoration Flows, velocities would decrease as water inundates more of the floodplain. Highly erodible areas would be reinforced by the Project (such as areas below concrete structures and at river bends) and water velocities and erosional forces are expected to be negligible in areas away from the main channel. Therefore, flood flows and Restoration Flows would not cause significant impacts to cultural resources in previously undisturbed areas that are located on the floodplain and outside of the main channel. Archaeological sites within and adjacent to the San Joaquin River would continue to be exposed to Friant Dam releases during ongoing operations, but higher flows would be distributed over the floodplain.

When comparing Alternative A to existing conditions, impacts to cultural resources on the floodplain would be similar to those described in the preceding paragraph (i.e., the comparison of Alternative A to the No-Action Alternative). This impact would be **less than significant**.

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Key features of Alternative B include construction of a new levee system to establish a bypass channel to northeast of the existing river channel, Compact Bypass Control Structure, Mendota Pool Control Structure, and re-route of Drive 10 ½. No construction activities are proposed at or near Mendota Dam, which falls outside the Project boundary under Alternative B. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

Impact CUL-1 (Alternative B): ***Effects on Archaeological Resources from Ground Disturbing Activities during Construction.*** Refer to Impact CUL-1 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. This impact would be **potentially significant**.

Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative B): ***Comply with Section 106 of the NHPA or Equivalent, Conduct Archaeological Monitoring in Proximity to Identified Sites or Areas of Sensitivity, Halt Work in the Event of an Archaeological Discovery, Plan an Intentional Site Burial Preservation in Place,*** **and** ***Avoid Soil Borrowing in the Vicinity of Known Archaeological Resources.*** Refer to Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative A). The same measures would be used here. This impact would be **less than significant** after mitigation.

Impact CUL-2 (Alternative B): ***Effects to Historical Properties Listed or Eligible for Listing in the National or California Register.*** Refer to Impact CUL-3 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. There would be **no impact**.

Impact CUL-3 (Alternative B): ***Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.*** Refer to Impact CUL-4 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. This impact would be **less than significant**.

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Key features of Alternative C include construction of new fish passage facilities at Mendota Dam, grade control structures downstream of Mendota Dam, a new Fresno Slough Dam, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Impact CUL-1 (Alternative C): ***Effects on Archaeological Resources from Ground Disturbing Activities during Construction.*** Refer to Impact CUL-1 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. This impact would be **potentially significant**.

Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative C): ***Comply with Section 106 of the NHPA or Equivalent, Conduct Archaeological Monitoring in Proximity to Identified Sites or Areas of Sensitivity, Halt Work in the Event of an Archaeological Discovery, Plan an Intentional Site Burial Preservation in Place,*** **and** ***Avoid Soil Borrowing, or other Ground Disturbing Activity in the Vicinity of Known Archaeological Resources.*** Refer to Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative A). The same measures would be used here. This impact would be **less than significant** after mitigation.

Impact CUL-2 (Alternative C): ***Effects to Historical Properties Listed or Eligible for Listing in the National or California Register.*** In comparison to the No-Action Alternative, Alternative C would include construction of a fish ladder at Mendota Dam and modification in Mendota Dam operations. This would cause physical changes to the Mendota Dam due to the addition of a fish ladder. Alternative C would also cause a small realignment to a section of the DMC where it transitions into Mendota Pool. An inlet canal is proposed at this transition location that would take water from the upstream side of the proposed Fresno Slough Dam, run north adjacent to the west side of the San Joaquin River, and connect to the Main Canal and Helm Ditch just west of their current intakes. This would cause only a minor physical change to the DMC. Because this alternative proposes physical changes to the Mendota Dam, which is eligible for listing as a historic property under Section 106 and is a historical resource listed in the California Register, a substantial adverse change or adverse effect could occur to this resource.

While the physical alterations of Mendota Dam required for the Project may not destroy the resource, it may change the resource such that it would no longer convey its significance; hence, this would be considered a substantial adverse change to the resource. While the significance of the resources is more related to its association with early irrigation public works in the Central Valley, rather than its architectural distinction, the alterations proposed may diminish the capacity of the resource to resemble its historic period of significance.

When comparing Alternative C to existing conditions, impacts to architectural resources would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative C to the No-Action Alternative). This would be a **potentially significant** impact.

Mitigation Measure CUL-2 (Alternative C): ***Follow the Secretary of the Interior's Standards for the Treatment of Historic Properties.*** Alterations to historical buildings or structures will conform to the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (Weeks and Grimmer 1995). Where new structures are required as elements of improved fish passage, such as the new proposed fish ladder at Mendota Dam, designs that are compatible with the overall character of the historic property are preferred. This includes the continuation of the existing character through the use of materials as well as consistent use of color and placement which reduces overall visual effects. This mitigation measure would reduce impacts on significant historical buildings and structures to a **less-than-significant** level.

> **Implementation Action:** Alterations to historical buildings or structures would conform to the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (Weeks and Grimmer 1995).
>
> **Location:** Construction activities at Mendota Dam.
>
> **Effectiveness Criteria:** Secretary of the Interior's Standards are met.
>
> **Responsible Agency:** Reclamation and CSLC.
>
> **Monitoring/Reporting Action:** Reclamation and/or CSLC staff will report to SHPO and the consulting parties.
>
> **Timing:** Prior to and during construction activities at Mendota Dam.

Impact CUL-3 (Alternative C): ***Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.*** Refer to Impact CUL-4 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. This impact would be **less than significant**.

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Key features of Alternative D include construction of new fish passage facilities at Mendota Dam, grade control structures downstream of Mendota Dam, Fresno Slough Dam, Main Canal and Helm Ditch relocations, and the North Canal. Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Impact CUL-1 (Alternative D): ***Effects on Archaeological Resources from Ground Disturbing Activities during Construction.*** Refer to Impact CUL-1 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. This impact would be **potentially significant**.

Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative D): ***Comply with Section 106 of the NHPA or Equivalent, Conduct Archaeological Monitoring in Proximity to Identified Sites or Areas of Sensitivity, Halt Work in the Event of an Archaeological Discovery, Plan an Intentional Site Burial Preservation in Place,*** **and** ***Avoid Soil Borrowing, or other Ground Disturbing Activity in the Vicinity of Known Archaeological Resources.*** Refer to Mitigation Measures CUL-1A, CUL-1B, CUL-1C, CUL-1D, and CUL-1E (Alternative A). The same measures would be used here. This impact would be **less than significant** after mitigation.

Impact CUL-2 (Alternative D): ***Effects to Historical Properties Listed or Eligible for Listing in the National or California Register.*** Refer to Impact CUL-3 (Alternative C). Because this alternative proposes changes to the Mendota Dam, a historic property under Section 106 and a historical resource listed in the California Register, this may cause substantial adverse change or adverse effects to this resource. This impact would be **potentially significant**.

Mitigation Measure CUL-2 (Alternative D): ***Follow the Secretary of the Interior's Standards for the Treatment of Historic Properties.*** Refer to Mitigation Measure CUL-2 (Alternative C). The same measure would be used here. This impact would be **less than significant** after mitigation.

Impact CUL-3 (Alternative D): ***Effects on Cultural Resources during the Operations and Maintenance Phase of the Project.*** Refer to Impact CUL-4 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. This impact would be **less than significant**.

10.0 Environmental Justice

Environmental justice is generally defined as:

> *"The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies" (U.S. Department of Energy 1997).*

The purpose of the environmental justice analysis is to determine whether disproportionately high and adverse environmental and economic effects would be realized by minority and/or low-income populations with implementation of projects, programs, or policies. To facilitate this analysis, information on the demographic and social characteristics of the population in the Project area has been collected to determine the extent to which minority and/or low-income populations exist in the region. This information is presented in Section 10.1. Section 10.2 presents the regulatory setting applicable to environmental justice. In Section 10.3, the anticipated environmental and socioeconomic impacts of the Project are assessed in the context of environmental justice populations of concern.

10.1 Environmental Setting

This section describes the demographic and socioeconomic characteristics of populations potentially affected by the Project, which serve as the foundation of the environmental justice analysis. The geographic area considered for the environmental justice analysis covers the two counties within which Reach 2B is located (i.e., Fresno and Madera counties, hereinafter referred to as the two-county region). It also includes the three census tracts (CT) in proximity to Reach 2B (i.e., CT 39, CT 83.01, and CT 4). The location of these census tracts are shown on Figure 10-1.

Environmental justice focuses on minority and low-income populations, and therefore topics addressed include race and ethnicity and relevant economic indicators of social well-being, including income and poverty. In addition, based on the strong connection between the Project area and the agricultural industry, information on these environmental justice parameters is also presented for local agricultural workforce.

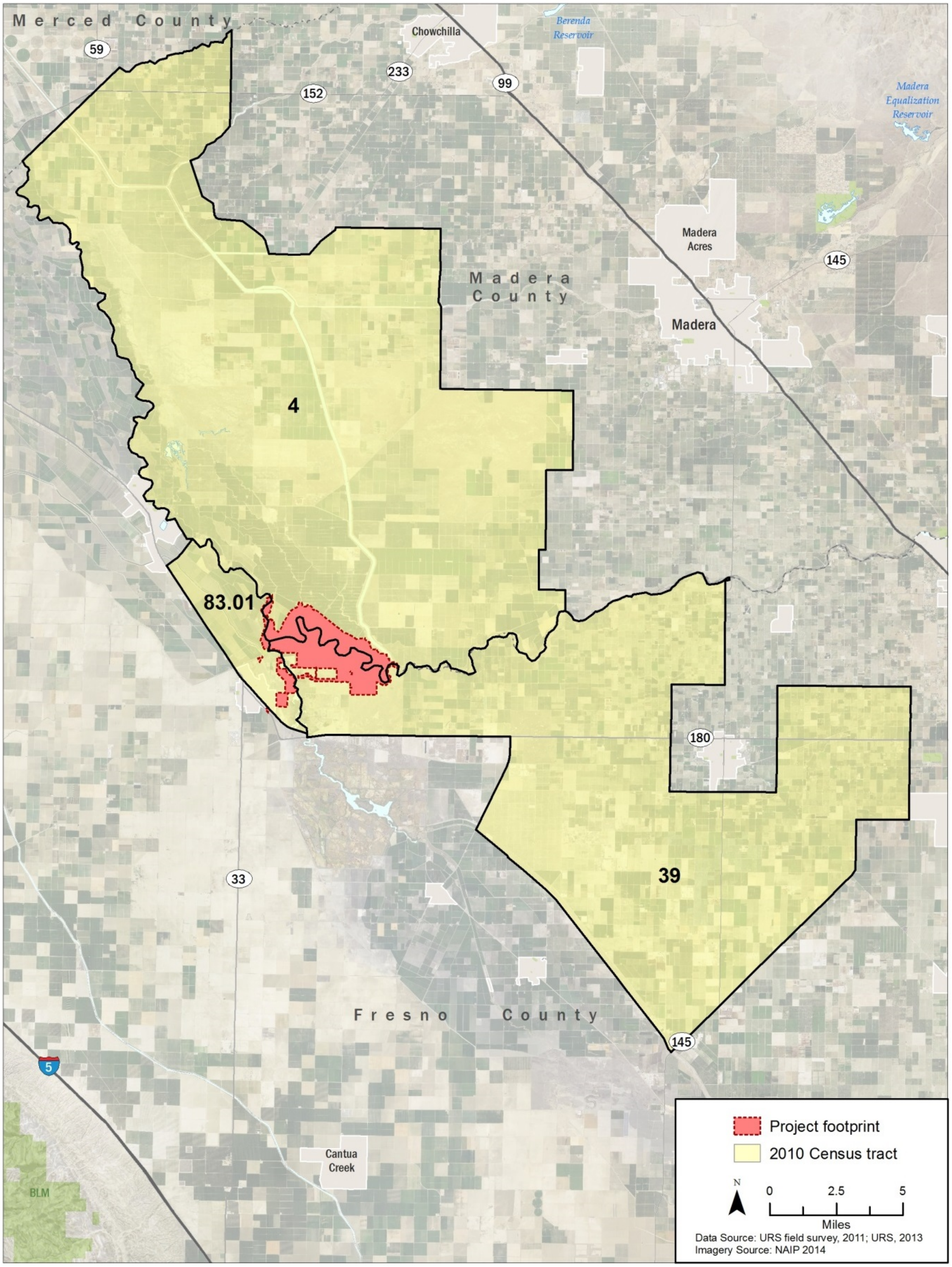

Figure 10-1.
Census Tracts near Reach 2B

The social and demographic characteristics of the Project area were evaluated to determine if any environmental justice communities of concern exist locally. This is determined based on the comparison of select social and demographic parameters for the Project area relative to the State, which serves as the reference population. If the minority or low-income populations are "meaningfully greater" in the region relative to this reference population, or where the proportion exceeds 50 percent of the total population, then an environmental justice community of concern is assumed to be present.

10.1.1 Social and Demographic Characteristics

Race and Ethnicity (Minority Populations)

The Council on Environmental Quality (CEQ 1997) defines a minority as persons who identify themselves as *Black/African American*, *Asian*, *Native Hawaiian or Other Pacific Islander*, and *American Indian or Alaska Native*. For the purposes of this analysis, the definition of minority also extends to other nonwhite categories of race, which include *Some Other Race* and *Two or More Races*. The CEQ guidance also identifies persons of *Hispanic* ethnicity, regardless of race, as part of minority populations (CEQ 1997). Hispanic origin is considered to be an ethnic category separate from race, according to the U.S. Census. These definitions apply here even though the minority populations within the State when combined are greater than 50 percent (as shown in Table 10-1 below).

Table 10-1 displays the potentially affected minority groups within the Project area based on the most recent decennial census data from the U.S. Census Bureau. The category "total minority" includes all residents except non-Hispanic whites, who are not considered minorities. As shown, the State and both Fresno and Madera counties have a minority population exceeding 50 percent. Together, the two-county region contains a minority population of 66.5 percent. The three CTs within the Project area also exceed 50 percent, with a joint minority population of 83.3 percent. In fact, CT 83.01 in Fresno County has an exceptionally high proportion of minorities (97.7 percent). Further, the CTs and two-county region both have a higher minority population compared to the State. These data suggest that the Project area and vicinity is considered an environmental justice community of concern from the perspective of race and ethnicity.

Table 10-2 presents the racial and ethnic composition of farm operators within the two-county region and State based on the most recent census of agriculture from the U.S. Department of Agriculture. Information on the race and ethnicity of farm operators at the CT level is not available. The farm operator is the person who runs the farm, making the day-to-day management decisions. The operator could be an owner, hired manager, cash tenant, share tenant, and/or a partner. As shown, the majority of farm operators in the two-county region are white (69.3 percent), which is representative of patterns in the State as a whole. There are slightly higher proportions of farm operators identifying as Asian and Hispanics in the two-county region compared to the State.

Table 10-1.
Race and Ethnicity of Local Population, 2010

Geo-graphic Area	Total Population	Race: White	Race: Black or African-American	Race: American Indian	Race: Asian	Race: Native Hawaiian/ Pacific Islander	Race: Some Other Race	Race: Two or More Races	Hispanic Origin: White Alone, Non-Hispanic	Hispanic Origin: All Races, Hispanic [a]	Total Minority [b]
Fresno County	930,450	515,145	49,523	15,649	89,357	1,405	217,085	42,286	304,522	468,070	625,928
	100.0%	55.4%	5.3%	1.7%	9.6%	0.2%	23.3%	4.5%	32.7%	50.3%	67.3%
CT 39	5,804	3,257	26	209	94	0	2,005	213	1,633	4,008	4,171
	100.0%	56.1%	0.4%	3.6%	1.6%	0.0%	34.5%	3.7%	28.1%	69.1%	71.9%
CT 83.01	5,989	3,028	58	71	55	5	2,572	200	140	5,782	5,849
	100.0%	50.6%	1.0%	1.2%	0.9%	0.1%	42.9%	3.3%	2.3%	96.5%	97.7%
Madera County	150,865	94,456	5,629	4,136	2,802	162	37,380	6,300	57,380	80,992	93,485
	100.0%	62.6%	3.7%	2.7%	1.9%	0.1%	24.8%	4.2%	38.0%	53.7%	62.0%
CT 4	1,288	798	11	12	4	1	412	50	412	851	876
	100.0%	61.8%	0.6%	1.1%	2.2%	0.4%	29.1%	4.9%	38.7%	56.6%	61.3%
Total CT's	13,081	7,083	95	292	153	6	4,989	463	2,185	10,641	10,896
	100.0%	54.1%	0.7%	2.2%	1.2%	0.0%	38.1%	3.5%	16.7%	81.3%	83.3%
Two-County Region	1,081,315	609,601	55,152	19,785	92,159	1,567	254,465	48,586	361,902	549,062	719,413
	100.0%	56.4%	5.1%	1.8%	8.5%	0.1%	23.5%	4.5%	33.5%	50.8%	66.5%
State	37,253,956	21,453,934	2,299,072	362,801	4,861,007	144,386	6,317,372	1,815,384	14,956,253	14,013,719	22,297,703
	100.0%	57.6%	6.2%	1.0%	13.0%	0.4%	17.0%	4.9%	40.1%	37.6%	59.9%

Source: U.S. Census Bureau 2010

Notes:

[a] The term “Hispanic” is an ethnic category and can apply to members of any race, including respondents who self-identified as “white.” The total numbers of Hispanic residents for each geographic region are tabulated separately from the racial distribution by the U.S. Census Bureau. Hispanic information is taken from U.S. Census Bureau 2010, while data regarding race are taken from U.S. Census Bureau 2010, Table P7.

[b] “Total minority” is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race. Total minority information is taken from U.S. Census Bureau 2010, with the total for “Not Hispanic or Latino: White alone” subtracted from the total population.

Key: % = percent, CT = Census Tract

**Table 10-2.
Race and Ethnicity of Farm Operators, 2012**

Geo-graphic Area	Total Farm Operators	White	Black or African-American	American Indian	Asian	Native Hawaiian / Pacific Islander	More Than One Race	All Race, Hispanic
Fresno County	10,378	6,964	52	140	1,499	36	71	1,616
	100.0%	67.1%	0.5%	1.3%	14.4%	0.3%	0.7%	15.6%
Madera County	2,715	2,106	15	24	234	8	8	320
	100.0%	77.6%	N/A	0.9%	8.6%	0.3%	0.3%	11.8%
Two-county Region	13,093	9,070	67	164	1,733	44	79	1,936
	100.0%	69.3%	0.5%	1.3%	13.2%	0.3%	0.6%	14.8%
California	137,510	111,141	526	1,761	7,474	455	1,030	15,123
	100.0%	80.8%	0.4%	1.3%	5.4%	0.3%	0.7%	11.0%

Source: USDA 2014, Census of Agriculture

Notes:

"Total Minority" cannot be computed from the data provided by the U.S. Department of Agriculture (USDA) Agricultural Census, as a tabulation of "White Alone, Non-Hispanic" farm operators is not provided.

Key:
% = percent
USDA = U.S. Department of Agriculture

Table 10-3 presents the racial and ethnic composition of laborers and helpers within the Project area based on the most recent Equal Employment Opportunity Tabulation data from the U.S. Census. Information on the race and ethnicity of laborers and helpers at the CT level is not available. The category "laborers and helpers" generally includes farm laborers, but may also include other manual labor sectors as part of the total. This category excludes construction personnel, which are captured under a different category by the U.S. Census Bureau. As shown, Hispanics comprise the largest proportion of laborers in each geographic area. The proportion of Hispanic laborers and helpers in the two-county region (86.4 percent) is higher to that in the State (71.3 percent). A similar pattern is found when evaluating all minority groups. The proportion of total minorities in this component of the workforce is 90.9 percent in the two-county region compared to 80.8 percent in the State.

Socioeconomic Indicators of Well-Being (Low-Income Populations)

For this analysis, persons with income below the poverty threshold established by the U.S. Census Bureau are considered low-income populations. Table 10-4 presents the median household income, per capita income, and proportion of individuals living below the poverty threshold for the Project area based on the most recent American Community Survey 5-year estimate from the U.S. Census Bureau. Any poverty rate which is at least double the statewide poverty rate is considered meaningfully greater for the purposes of this environmental justice analysis.

Table 10-3.
Race and Ethnicity of Laborers and Helpers, 2006-2010 Estimate

Geographic Area	Total Laborers and Helpers	Race (Not Hispanic or Latino)							All Race, Hispanic [a]	Total Minority [b]
		White	Black or African-American	American Indian	Asian	Native Hawaiian/ Pacific Islander	Some Other Race	Two or More Races		
Fresno County	46,120	4,085	580	130	1,160	0	295	160	39,710	42,035
	100.0%	8.9%	1.3%	0.3%	2.5%	0.0%	0.6%	0.4%	86.1%	91.2%
Madera County	10,145	1,045	100	10	40	0	10	34	8,905	9,099
	100.0%	10.3%	1.0%	0.1%	0.4%	0.0%	0.1%	0.3%	86.1%	88.0%
Two-county Region	56,265	5,130	680	140	1,200	0	305	194	48,615	51,134
	100.0%	9.1%	1.2%	0.2%	2.1%	0.0%	0.5%	0.3%	86.4%	90.9%
California	870,025	167,320	29,900	3,085	34,505	3,205	4,765	6,985	620,260	702,705
	100.0%	19.2%	3.4%	0.4%	4.0%	0.4%	0.5%	0.8%	71.3%	80.8%

Source: U.S. Census Bureau 2012 (EEO Tabulation 2006-2010)

Notes:

[a] The term “Hispanic” is an ethnic category and can apply to members of any race, including respondents who self-identified as “white.”

[b] “Total minority” is the aggregation of all non-white racial groups with the addition of all Hispanics, regardless of race.

Key:

% = percent

Table 10-4.
Income and Poverty, 2008-2012 Estimate

Geographic Area	Median Household Income	Per Capita Income	Population Below Poverty Threshold	
Fresno County	$45,741	$20,391	230,768	24.8%
CT 39	$34,135	$15,630	1,436	31.2%
CT 83.01	$34,607	$10,282	2,007	33.4%
Madera County	$47,937	$18,474	31,780	21.1%
CT 4	$33,750	$18,247	183	16.8%
Total CT's[1]	$34,164	$14,720	3,627	27.7%
Two-County Region[1]	$46,839	$19,433	262,548	24.3%
State of California	$61,400	$29,551	5,710,735	15.3%

Source: U.S. Census Bureau 2013, 2008-2012 American Community Survey 5-year estimates

Notes:

[1] Poverty rates calculated based on weighted population (relative to the percent population of each CT in the Total CT's and relative to the percent population of each county in the Two-County Region)

Key: % = percent

Overall, the two-county region contains a greater percentage of people living in poverty relative to the State (24.3 percent versus 15.3 percent, respectively); this does not exceed the threshold for this analysis. However, CT 39 and CT 83.01 in Fresno County have a meaningfully-greater proportion of people living below the poverty threshold at 31.2 percent and 33.4 percent, respectively. These data suggest that the Project area and vicinity is considered an environmental justice community of concern from the perspective of socioeconomic indicators.

Table 10-5 presents median annual wage information for farm-related occupations within the Project area based on recent data from the California Employment Development Department. As shown, the median wage for all farm-related occupations is $19,504 in Fresno County and $19,416 in Madera County. Both figures are less than the county-wide median wage for all industries ($41,852 and $43,956, respectively) and median wage earnings across the State ($52,630). All categories of agricultural workers earn less than the statewide average except for graders and sorters.[1] The information presented in Table 10-5 shows that median incomes in the farming industry are lower than the median income for all industries, with some less-skilled agricultural workers earning substantially less than regional averages.

[1] Comparable data for Agricultural Inspectors, Graders and Sorters, and Agricultural Workers, Other for Madera County were not available.

**Table 10-5.
Agricultural Workers Median Annual Wages, 2012 (1st Quarter)**

Geographic Area	Farming, Fishing, and Forestry Occupations-Overall	First-Line Supervisors	Agricultural Inspectors	Graders and Sorters	Equipment Operators	Farmworker (Crop, Nursery, Greenhouse)	Farmworker (Farm and Ranch Animals)	Agricultural Workers, Other	Median Wage, All Industries
Fresno County	$19,504	$31,512	$41,275	$19,847	$19,836	$18,821	$21,368	$38,584	$41,852
Madera County	$19,416	$30,158	$23,755	--	$22,064	$18,639	$20,249	--	$43,956
California	$20,944	$43,598	$47,283	$19,594	$24,150	$19,551	$25,672	$28,725	$52,630

Source: California EDD 2012
Key:
-- = data not available

10.1.2 Long-term Challenges for Agricultural Lands

Future water demand in the Central Valley is affected by a number of growth and land use factors, including population growth, planting decisions by farmers, and size and type of urban landscapes. Future population growth and development density will determine the extent of the urban landscape and encroachment into agricultural lands. The *California Water Plan* (Department of Water Resources 2013) has evaluated several growth and climate change scenarios and predicts an increase in urban water demand associated with increased population growth, a decrease in agricultural water demand due to a reduction in irrigated crop acreage (and due to an increase in water conservation measures for agriculture), and a decrease in agricultural supply reliability in the Central Valley. The Central Valley could experience increased fallowing of agricultural lands and an associated decrease in farm-related occupations, which could affect environmental justice communities. How these trends would apply specifically to Reach 2B is unknown.

10.2 Regulatory Setting

This section describes the Federal, State, regional, and local regulatory setting related to environmental justice.

10.2.1 Federal

Federal laws and regulations pertaining to environmental justice in the Project area are summarized briefly below.

Executive Order 12898

In 1994, President Clinton issued Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (1994)*. EO 12898 requires each Federal agency to achieve environmental justice as part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects, including social or economic effects, of programs, policies, and activities on minority and low-income populations of the United States.

Council on Environmental Quality Guidance

The CEQ prepared *Environmental Justice Guidance under the National Environmental Policy Act* to assist Federal agencies in meeting their environmental justice commitments under the National Environmental Policy Act (NEPA). This guidance provides the following definition of the terms “minority” and “low income community” in the context of environmental justice analysis. Minority individuals are members of the following population groups: American Indian or Alaskan Native, Asian or Pacific Islanders, Black, and Hispanic. A low income community is one found to be below the poverty thresholds from the U.S. Census Bureau. CEQ has oversight for the Federal government’s compliance with EO 12898 and NEPA process, with the U.S. Environmental Protection Agency (EPA) serving as the lead agency responsible for implementation of the EO.

Environmental Compliance Memoranda No. ECM 95-3

The U.S. Department of the Interior, Office of Environmental Policy and Compliance (1995) confirms the requirement of EO 12898 for the U.S. Department of the Interior to consider impacts on minority and low-income populations and communities. A letter responding to an earlier request by the Secretary of the Interior states, "[H]enceforth, all environmental documents should specifically analyze and evaluate the impacts of any proposed projects, actions or decisions on minority and low-income populations and communities, as well as the equity of the distribution of the benefits and risks of those decisions."

10.2.2 State of California

State laws and regulations pertaining to environmental justice are discussed below.

Senate Bill 115

California was the first state to define environmental justice with Senate Bill (SB) 115. The bill defines environmental justice as "the fair treatment of people of all races, cultures and income with respect to development, adoption and implementation of environmental laws, regulations and policies." SB 115 added this language to California Government Code section 65040.12 and to Division 34 of the Public Resources Code relating to environmental quality. It also established the Governor's Office of Planning and Research as the coordinating agency for State programs and requested that the California Environmental Protection Agency (Cal/EPA) establish a model environmental justice policy for its boards, departments, and offices (California Resources Agency, undated).

California State Lands Commission Environmental Justice Policy

The California State Lands Commission (CSLC) pledges though its environmental justice policy to continue and enhance its processes, decisions, and programs with environmental justice as an essential consideration. It defines "environmental justice" in a manner consistent with the State as "the fair treatment of people of all races, cultures and income with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." This definition is consistent with the Public Trust Doctrine principle that the management of trust lands is for the benefit of all of the people. The purpose of the environmental justice policy is to ensure that environmental justice is an essential consideration in the CSLC's processes, decisions and programs and that all people who live in California have a meaningful way to participate in these activities. Implementation of CSLC's environmental justice policy is similar to implementation of environmental justice under the NEPA process.

10.2.3 Regional and Local

There are no known regional or local plans or policies related to environmental justice.

10.3 Environmental Consequences and Mitigation Measures

10.3.1 Impact Assessment Methodology

This section describes the approach used to conduct the assessment of potential effects related to environmental justice. This assessment utilizes information on the demographic and social characteristics of the Project area to determine whether there are minority or low-income populations that could be disproportionately and adversely affected by the Project alternatives. The identification of minority and low-income populations in the Project area is based on a comparison of select social and demographic characteristics, including race, per capita income and poverty rates, of communities that would be affected by the Project (e.g., city of Mendota) with a reference population (the State). Minority or low-income populations in the Project area that are meaningfully greater in proportion than in the reference population are considered environmental justice populations of concern.

The minority and low-income populations prevalent in the Project area have been evaluated in the context of the potential for adverse socioeconomic and environmental effects of the Project to determine if they would be disproportionately affected. The evaluation of environmental justice effects on minority and low-income populations considers the magnitude and timing of economic and environmental impacts and the nexus between such impacts and the affected populations, including their extent of use of affected resources, such as resources that support subsistence living.

10.3.2 Disproportionately High and Adverse Criteria

Under NEPA, an analysis of environmental justice effects is required; however, there is no standard set of criteria for evaluating environmental justice impacts. Under the California Environmental Quality Act (CEQA), economic and social impacts are not considered significant effects on the environment; therefore, there is no guidance on assessing environmental justice effects in the State CEQA Guidelines Appendix G. For this analysis, the Project would result in an environmental justice impact if it would result in any of the following:

- An impact on the natural or physical environment that substantially and adversely affects a minority population, low-income population, or Indian tribe disproportionately relative to the general population. Such effects may include ecological, cultural, and human health impacts from environmental hazards.
- An economic or social impact on the human environment that substantially and adversely affects a minority population, low-income population, or Indian tribe disproportionately relative to the general population. Such effects may include reductions in income and employment opportunities.
- Physical impacts on resources, such as fish and wildlife, which are used for subsistence consumption.

If an impact remains significant after all mitigation is implemented, then the impact is included in the environmental justice analysis, and the equity of the impact across the Project area population is determined. In instances where the location of the impact could be described, the demographic characteristics of the surrounding area were assessed to determine whether a minority or low-income population meaningfully greater than the proportion of minority and/or low-income residents in the general population was present. “Meaningfully greater” populations were interpreted to be either 50 percent of the total population of the geographic unit or simply “greater” than any other population group within the surrounding, larger geography (which provides for a more conservative analysis). Otherwise, the environmental justice analysis is evaluated at a broader, more regional scale. Potentially significant and unavoidable impacts and significant and unavoidable impacts are identified in other chapters of this Environmental Impact Statement/Report (EIS/R).

10.3.3 Impacts and Mitigation Measures

This section describes a project-level evaluation of potential impacts to environmental justice communities of concern in the Project area from impacts on the natural or physical environment (ecological, cultural, and human health impacts). The primary impacts of the Project alternatives that factor in the environmental justice analysis are associated with removing agricultural lands from production and Project construction and operations expenditures, which affect socioeconomic conditions throughout the regional economy. This section includes analyses of potential effects relative to No-Action conditions in accordance with NEPA. This methodology will serve to address the State policies explained in Section 10.2.2. The analysis is organized by Project alternative with specific impact topics numbered sequentially under each alternative. With respect to environmental justice, the relevant issues and concerns are:

1. Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production.
2. Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production.
3. Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations.
4. Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts.
5. Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances
6. Effects on Environmental Justice Communities of Concern from Construction-Related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.
7. Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).
8. Effects on Environmental Justice Communities of Concern from Inadequate or Reduced Emergency Access

There are other environmental justice-related issues covered in the Program Environmental Impact Statement/Report (PEIS/R) that are not covered here because they are not relevant to the Project area.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the San Joaquin River Restoration Program (SJRRP) would be implemented, including habitat restoration, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, these activities would not achieve the Settlement goals. The analysis of environmental justice effects of the No-Action Alternative is based on a comparison to existing conditions.

Impact EJ-1 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production*.** Under the No-Action Alternative, there would not be any land removed from agricultural production to accommodate the Project. Therefore, compared to existing conditions, a substantial decrease in the quantity of agricultural lands in the Project area would be unlikely, the No-Action Alternative would result in continued agricultural production, and local agricultural operations would continue to employ farm laborers and provide labor income to these workers, who are typically of Hispanic origin and generally part of the low-income population in the region. Disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-2 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production*.** As described in Impact EJ-1 (No-Action Alternative), there would likely be little to no land removed from agricultural production under the No-Action Alternative. Therefore, compared to existing conditions, there would be no change and local farms would continue to make expenditures in the local economy to support their operations, thereby generating economic benefits throughout Fresno and Madera counties, as measured by economic output, labor income, and jobs. Some of these regional benefits would accrue to minority and low-income populations residing in the two-county region. Disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-3 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations*.** Under the No-Action Alternative, the Project would not be implemented and there would not be any construction- and operations-related expenditures or employment supported by the Project that would generate economic benefits in the two-county region. There would be no change compared to existing conditions. Disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-4 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and***

Cancellation of Williamson Act Contracts. Under the No-Action Alternative, the Project would not be implemented and there would not be any Project-related conversion of designated farmland to non-agricultural uses or cancellation of Williamson Act contracts that would affect agricultural workers which are disproportionately racial and/or ethnic minorities relative to State demographics. There would be no change compared to existing conditions as a result of Project-related activities. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-5 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances*****.** Under the No-Action Alternative, the Project would not be implemented and there would not be Project-related conflicts with adopted land use plans, goals, policies, and ordinances that would affect agricultural workers, which are disproportionately racial and/or ethnic minorities relative to State demographics. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-6 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Construction-related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.*** Under the No-Action Alternative, the existing regulatory framework would likely minimize adverse effects from emission of criteria air pollutants and precursors in localized areas. Local regulations that require dust abatement and criteria pollutant emissions reduction during construction are expected to reduce these impacts. However, there could be residual significant and unavoidable impacts from construction activities within the San Joaquin Valley Air Basin (SJVAB) that are unrelated to the Project, and regional effects could disproportionately affect low-income groups. If the SJVAB remains in nonattainment status for criteria air pollutants, then health impacts associated with poor air quality could affect low-income residents with less access to health care. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact EJ-7 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).*** Under the No-Action Alternative, the Project would not be implemented and there would not be any Project-related physical changes on resources that would affect subsistence consumers which are disproportionately racial and/or ethnic minorities relative to State demographics. There would be no change compared to existing conditions as a result of Project-related activities. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Impact EJ-8 (No-Action Alternative): ***Effects on Environmental Justice Communities of Concern from Reduced Inadequate or Emergency Access*****.** Under the No-Action Alternative, the Project would not be implemented and there would not be changes in emergency access that would affect agricultural workers, which are disproportionately racial and/or ethnic minorities relative to State demographics. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under the No-Action Alternative.

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

All of the Project alternatives, including Alternative A, would entail habitat restoration activities in conjunction with an expanded floodplain and widened levee alignment, as well as new Project facilities that promote fish passage through Reach 2B. The Project would result in adverse impacts on agricultural resources (refer to Chapter 16, "Land Use Planning and Agricultural Resources") and generate both socioeconomic impacts associated with losses in agricultural production and benefits attributed to construction and operations spending (refer to Chapter 21, "Socioeconomics and Economics").

Impact EJ-1 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production.*** Compared to No-Action, Alternative A would permanently remove approximately 1,180 acres of agricultural land from production and 580 acres of cropland would likely be shifted to livestock grazing. Additional agricultural land would also be temporarily taken out of production affected during the multi-year construction period. Under Alternative A, termination of agricultural production on lands within the Project area would result in lower demand for farm labor. It is anticipated that 40 farm-level jobs and $1.8 million in annual labor income would be permanently lost when agricultural land is removed from production under Alternative A; temporary effects during construction are relatively minor. As described above, the agricultural labor force predominantly consists of workers of Hispanic origin with relatively low incomes. As a result, the adverse effects on local agricultural operations would be realized by an environmental justice community of concern in the Project area. Therefore, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative A.

Impact EJ-2 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production.*** Compared to No-Action, Alternative A would result in a decline in regional economic activity in the two-county region, namely losses in economic output (or production), labor income and jobs, in conjunction with decreased agricultural production in the Project area. Considering the inter-industry linkages between the agricultural sector and other sectors of the regional economy (i.e., "ripple" or multiplier effects), the total economic impacts in Fresno and Madera counties attributed to decreased agricultural production in the Project area include annual losses of 75 jobs and $3.1 million in labor income over the long term under Alternative A. While the direct economic impacts would primarily occur in the agricultural sector, as described in Impact EJ-1 (Alternative A), the regional economic impacts would be more widespread, affecting a range of industries, including agricultural-support and other businesses linked to agriculture. As such, the regional economic impacts would affect a cross-section of the local population, which has a relatively high proportion of minority and low-income residents. However, it is difficult to predict the extent to which these adverse effects would be realized by minority and/or low-income populations living in the region. As a result of impacts on regional economic conditions, disproportionately high and adverse effects on minority and low-income populations in the region **could occur** under Alternative A.

Impact EJ-3 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations*****.** Compared to No-Action, Alternative A would benefit the regional economy based on construction and operations expenditures that would generate increases in economic output, labor income and jobs based on inter-industry linkages among affected sectors in the economy. Within the two-county region, construction activity is expected to support a total of approximately 293 jobs and $19.7 million in labor income annually over the construction period under Alternative A. Over the long term, operations expenditures would support about $705,000 in labor income annually and 14 jobs in the region. The direct short-and long-term economic benefits would primarily occur in construction-related sectors, while the regional economic benefits would affect a wide range of industries. Accordingly, the increase in economic activity would benefit a cross-section of the local population, which is characterized by a relatively-high proportion of minority and low-income residents as described above. However, it is difficult to predict the extent to which these beneficial employment and income effects would be realized by minority and/or low-income populations living in the region. Disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative A.

Impact EJ-4 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts.*** Proposed land use conversions associated with Alternative A would be inconsistent with local policies that call for the agricultural productivity of designated Farmland to be preserved and Williamson Act contracts to be maintained to the extent possible. The conversion of designated Farmland and cancellation of Williamson Act contracts could occur in the Project area. This significant and unavoidable impact is not expected to disproportionately affect specific geographic concentrations of low-income populations or minority groups because the effects would be distributed. However, the agricultural workers affected by reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to State demographics. The percentage of low-income agricultural workers who work in this area is also high. Therefore, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative A.

Impact EJ-5 (Alternative A): ***Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances*****.** Proposed land use conversion in the Project area would conflict with adopted land use plans, goals, policies, and ordinances of affected jurisdictions. To recognize and minimize adverse effects on agricultural land use and zoning, Project proponents would notify Fresno and Madera County planning agencies of inconsistencies in designations and applicable polices for the affected areas. The population affected by land use conversion includes only one or two residences, which is too few for a disproportionately high and adverse effect. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact EJ-6 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Construction-related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.*** The existing regulatory framework would minimize adverse effects from emission of criteria air pollutants and precursors near the Project area. However, there could be residual significant and unavoidable impacts from construction activities within the SJVAB, and regional and local effects could disproportionately affect low-income groups. If the SJVAB remains in nonattainment status for criteria air pollutants, then health impacts associated with poor air quality could regionally affect low-income residents with less access to health care. Project-related construction could affect local minority and low-income sensitive receptors. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact EJ-7 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).*** In Reach 2B, the primary resource for subsistence consumption is fishing in Mendota Pool and the river just downstream of Mendota Dam. Alternative A would not make physical changes to the portion of Mendota Pool that is publically accessible and typically used for fishing opportunities. Compared to the No-Action Alternative, the effects of Alternative A would be the same. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative A.

Impact EJ-8 (Alternative A): ***Effects on Environmental Justice Communities of Concern from Inadequate or Reduced Emergency Access.*** Project alternatives would create temporary or permanent roadway discontinuities at Drive 10 ½ and/or the San Mateo Avenue crossing that could reduce emergency response times to private property north of the river. The potentially affected population includes residences and agricultural workers. Agricultural workers would be able to flee potential dangers such as brush fires and use alternative evacuation routes. Response times to residences north of the river near the crossings could be affected; however, the number of residences is too few for a disproportionately high and adverse effect. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B proposes habitat restoration activities in conjunction with an expanded floodplain and widened levee alignment, as well as new Project facilities that promote fish passage through Reach 2B. The Project would result in adverse impacts on agricultural resources (refer to Chapter 16, “Land Use Planning and Agricultural Resources”) and generate both socioeconomic impacts associated with losses in agricultural production and benefits attributed to construction and operations spending (refer to Chapter 21, “Socioeconomics and Economics”).

Impact EJ-1 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production.*** Alternative B would generally have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-1 (Alternative A) for more details. Compared to No-Action, Alternative B would permanently remove approximately 1,032 acres of agricultural land from production, and additional agricultural land would also be temporarily taken out of production affected during the multi-year construction period. In the context of environmental justice, it is anticipated that approximately 46 farm-level jobs and $2.1 million in annual labor income would be permanently lost under Alternative B, which would be realized predominantly by Hispanic workers characterized by low income levels. Therefore, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative B.

Impact EJ-2 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production*****.** Alternative B would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-2 (Alternative A) for more details. Compared to No-Action, Alternative B would adversely affect the regional economy based on reductions in agricultural production in the Project area. Agricultural production losses under Alternative B would result in total losses of 93 jobs and $3.8 million annually over the long term throughout Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations; therefore, the regional economic impacts anticipated with the Project could adversely affect minority and/or low-income populations residing in the region. As a result, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative B.

Impact EJ-3 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations*****.** Alternative B would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-3 (Alternative A) for more details. Compared to No-Action, Alternative B would generate regional economic benefits based on new spending on construction and operations activities associated with the Project. Within the two-county region, construction activity is expected to support a total of approximately 244 jobs and $16.1 million in labor income annually over the construction period. In addition, operations expenditures would support about $600,000 in labor income annually and 12 jobs over the long term. The regional economic benefits of Project construction and operations anticipated under Alternative B would benefit local residents in Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations. As a result, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative B.

Impact EJ-4 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts.*** This analysis and conclusion is the same as Impact EJ-4 (Alternative A). The conversion of designated Farmland and cancellation of Williamson Act contracts would occur in the Project area and agricultural workers affected by the reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to State demographics. Disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative B.

Impact EJ-5 (Alternative B): ***Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances*.** Alternative B would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-5 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact EJ-6 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Construction-related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.*** This analysis and conclusion is the same as Impact EJ-4 (Alternative A). Regional and local effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact EJ-7 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).*** In Reach 2B, the primary resource for subsistence consumption is fishing in Mendota Pool and the river just downstream of Mendota Dam. Alternative B would not make physical changes to the portion of Mendota Pool that is publically accessible and typically used for fishing opportunities. Compared to the No-Action Alternative, the effects of Alternative B would be the same. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative B.

Impact EJ-8 (Alternative B): ***Effects on Environmental Justice Communities of Concern from Reduced Inadequate or Emergency Access*.** Alternative B would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-8 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C proposes habitat restoration activities in conjunction with an expanded floodplain and widened levee alignment, as well as new Project facilities that promote fish passage through Reach 2B. The Project would result in adverse impacts on agricultural resources (refer to Chapter 16, "Land Use Planning and Agricultural Resources") and generate both socioeconomic impacts associated with losses in agricultural production and benefits attributed to construction and operations spending (refer to Chapter 21, "Socioeconomics and Economics").

Impact EJ-1 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production***. Alternative C would generally have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-1 (Alternative A) for more details.

Compared to No-Action, Alternative C would permanently remove approximately 1,520 acres of agricultural land from production, and additional agricultural land would also be temporarily taken out of production affected during the multi-year construction period. In the context of environmental justice, it is anticipated that approximately 37 farm-level jobs and $1.7 million in annual labor income would be permanently lost under Alternative C, which would be realized predominantly by Hispanic workers characterized by relatively low income levels. Therefore, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative C.

Impact EJ-2 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production*.** Alternative C would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-2 (Alternative A) for more details. Compared to No-Action, Alternative C would adversely affect the regional economy based on reductions in agricultural production in the Project area. Agricultural production losses under Alternative C would result in total losses of 67 jobs and $2.7 million annually over the long term throughout Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations; therefore, the regional economic impacts anticipated with the Project could adversely affect minority and/or low-income populations residing in the region. As a result, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative C.

Impact EJ-3 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations*.** Alternative C would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-3 (Alternative A) for more details. Compared to No-Action, Alternative C would generate regional economic benefits based on new spending on construction and operations activities associated with the Project. Within the two-county region, construction activity is expected to support a total of approximately 287 jobs and $18.1 million in labor income annually over the construction period. In addition, operations expenditures would support about $557,000 in labor income annually and 11 jobs over the long term. The regional economic benefits of Project construction and operations anticipated under Alternative C would benefit local residents in Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations. As a result, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative C.

Impact EJ-4 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts.*** This analysis and conclusion is the same as Impact EJ-4 (Alternative A). The conversion of designated Farmland and cancellation of Williamson Act contracts would occur in the Project area and agricultural workers affected by the reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to State demographics. Disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative C.

Impact EJ-5 (Alternative C): ***Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances*.** Alternative C would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-5 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact EJ-6 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Construction-related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.*** This analysis and conclusion is the same as Impact EJ-4 (Alternative A). Regional and local effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact EJ-7 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).*** In Reach 2B, the primary resource for subsistence consumption is fishing in Mendota Pool and the river just downstream of Mendota Dam. Alternative C would change the extent of Mendota Pool, limiting it to Fresno Slough with the Fresno Slough Dam. The area at Mendota Dam would typically have run of the river conditions and fishing regulations used to protect endangered salmon would be enforced in the area. However, subsistence fishing could still continue in Mendota Pool and Fresno Slough, which would remain accessible at nearby Mendota Pool Park. Compared to the No-Action Alternative, the effects of Alternative C would be less than substantial. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative C.

Impact EJ-8 (Alternative C): ***Effects on Environmental Justice Communities of Concern from Reduced Inadequate or Emergency Access*.** Alternative C would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-8 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D proposes habitat restoration activities in conjunction with an expanded floodplain and widened levee alignment, as well as new Project facilities that promote fish passage through Reach 2B. The Project would result in adverse impacts on agricultural resources (refer to Chapter 16, “Land Use Planning and Agricultural Resources”) and generate both socioeconomic impacts associated with losses in agricultural production and benefits attributed to construction and operations spending (refer to Chapter 21, “Socioeconomics and Economics”).

Impact EJ-1 (Alternative D): ***Effects on Environmental Justice Communities of Concern from Removal of Land from Agricultural Production***. Alternative D would generally have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-1 (Alternative A) for more details.

Compared to No-Action, Alternative D would permanently remove approximately 1,290 acres of agricultural land from production and 960 acres of cropland would be shifted to livestock grazing. Additional agricultural land would also be temporarily taken out of production affected during the multi-year construction period. In the context of environmental justice, it is anticipated that approximately 56 farm-level jobs and $2.6 million in annual labor income would be permanently lost under Alternative D, which would be realized predominantly by Hispanic workers characterized by relatively low income levels. Therefore, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative D.

Impact EJ-2 (Alternative D): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Agricultural Production*.** Alternative D would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-2 (Alternative A) for more details. Compared to No-Action, Alternative D would adversely affect the regional economy based on reductions in agricultural production in the Project area. Agricultural production losses under Alternative D would result in total losses of 103 jobs and $4.3 million annually over the long term throughout Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations; therefore, the regional economic impacts anticipated with the Project could adversely affect minority and/or low-income populations residing in the region. As a result, disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative D.

Impact EJ-3 (Alternative D): ***Effects on Environmental Justice Communities of Concern from Changes in Regional Activity Attributed to Project Construction and Operations*.** Alternative D would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-3 (Alternative A) for more details. Compared to No-Action, Alternative D would generate regional economic benefits based on new spending on construction and operations activities associated with the Project. Within the two-county region, construction activity is expected to support a total of approximately 258 jobs and $15.8 million in labor income annually over the construction period. In addition, operations expenditures would support about $564,000 in labor income annually and 11 jobs over the long term. The regional economic benefits of Project construction and operations anticipated under Alternative D would benefit local residents in Fresno and Madera counties, which are characterized by relatively large numbers of minority and/or low-income populations. As a result, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative D.

Impact EJ-4 (Alternative D): ***Effects on Environmental Justice Communities of Concern from Conversion of Designated Farmland to Nonagricultural Uses and Cancellation of Williamson Act Contracts.*** This analysis and conclusion is the same as Impact EJ-4 (Alternative A). The conversion of designated Farmland and cancellation of Williamson Act contracts would occur in the Project area and agricultural workers affected by the reduced acreage of farmland are disproportionately racial and/or ethnic minorities relative to State demographics. Disproportionately high and adverse effects on minority and low-income populations **could occur** under Alternative D.

Impact EJ-5 (Alternative D): *Effects on Environmental Justice Communities of Concern due to Conflicts with Adopted Land Use Plans, Goals, Policies, and Ordinances*. Alternative D would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-5 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

Impact EJ-6 (Alternative D): *Effects on Environmental Justice Communities of Concern from Construction-related Emissions of Criteria Air Pollutants and Precursors and Exposure of Sensitive Receptors to Substantial Concentrations of Toxic Air Contaminants.* This analysis and conclusion is the same as Impact EJ-4 (Alternative A). Regional and local effects could disproportionately affect minority and low-income populations. Disproportionately high and adverse effects on minority and low-income populations **could occur**.

Impact EJ-7 (Alternative D): *Effects on Environmental Justice Communities of Concern from Physical Impacts on Resources Used for Subsistence Consumption (Fish and Wildlife).* In Reach 2B, the primary resource for subsistence consumption is fishing in Mendota Pool and the river just downstream of Mendota Dam. Alternative D would change the extent of Mendota Pool, limiting it to Fresno Slough with the Fresno Slough Dam. The area at Mendota Dam would typically have run of the river conditions and fishing regulations used to protect endangered salmon would be enforced in the area. However, subsistence fishing could still continue in Mendota Pool and Fresno Slough, which would remain accessible at nearby Mendota Pool Park. Compared to the No-Action Alternative, the effects of Alternative D would be less than substantial. Therefore, disproportionately high and adverse effects on minority and low-income populations **would not occur** under Alternative D.

Impact EJ-8 (Alternative D): *Effects on Environmental Justice Communities of Concern from Reduced Inadequate or Emergency Access*. Alternative D would have similar effects on environmental justice communities of concern as described for Alternative A; refer to Impact EJ-8 (Alternative A) for more details. Disproportionately high and adverse effects on minority and low-income populations **would not occur**.

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11.0 Geology and Soils

This chapter describes the environmental and regulatory settings for geology and soils, including mineral resources (sand, gravel, rock, gold, oil, and natural gas), erosion, sedimentation, and geomorphic processes. The chapter includes a discussion of existing geology and soils conditions and the potential impacts of the Project alternatives on geology and soils along the San Joaquin River from the Chowchilla Bifurcation Structure to approximately 2 miles below Mendota Dam. The Project area comprises the area that could be directly or indirectly affected by the Project. The Project area is located in Fresno and Madera counties, near the town of Mendota, California.

11.1 Environmental Setting

Because of the regional-scale nature of earth resources, the geology and soils characteristics addressed in this section are described in a regional context, referring to geologic and geomorphic provinces, physiographic regions, or other large-scale areas, as appropriate.

11.1.1 Geology

The various geologic processes active in California over millions of years have created many geologically and geomorphically different areas, called geomorphic provinces. The upper San Joaquin River lies in the Sierra Nevada Province and lower San Joaquin River and the Project area are in the Central Valley Province (California Geological Survey [CGS] 2002a).

The upper San Joaquin River is located in the central portion of the Sierra Nevada Province at its boundary with the eastern edge of the Central Valley Province. The Sierra Nevada Province encompasses the Sierra Nevada Mountains, and comprises primarily intrusive rocks, including granite and granodiorite,[1] with some metamorphic rocks that formed due to contact at depth with the intruding igneous rocks. Extrusive rocks also occur. Evidence of previous episodic volcanic activity within the San Joaquin River watershed includes discontinuous Pliocene to Pleistocene deposits observed within the middle fork of San Joaquin River, the Miocene deposits within the vicinity of Millerton Lake, and the Pleistocene Friant Pumice found downstream of Friant Dam (Wakabayashi and Sawyer 2001, Huber 1981, McBain & Trush 2002).

The Sierra Nevada Province is a tilted fault block nearly 400 miles long, with a high, steep multiple-scarp east face and a gently sloping west face that dips beneath the Central Valley Province (CGS 2002a). The central Sierra Nevada has a complex history of uplift and erosion. The greatest uplift tilted the entire Sierra Nevada block to the west. The high

[1] Granodiorite is an igneous rock similar to granite, but contains more plagioclase (calcium and sodium) feldspar than potassium feldspar and has more dark minerals.

elevation of the Sierra Nevada Mountains leads to the accumulation of snow, including the Pleistocene glaciation responsible for shaping much of the range. Snowmelt in the Sierra Nevada feeds the San Joaquin River and its major tributaries, including those upstream from Friant Dam as well as the Merced, Tuolumne, Stanislaus, and Mokelumne rivers and other tributaries downstream from the Merced River confluence. These large rivers and their smaller tributaries cut through the granitic rocks present in the upper San Joaquin River watershed, and through intrusive and extrusive rock formations and sedimentary and metamorphosed rocks farther to the west. The metamorphic bedrock in these watersheds contains gold-bearing veins in the northwest-trending Mother Lode that are not present in the more southerly watershed of the upper San Joaquin River (CGS 2002b).

The Central Valley Province encompasses the Central Valley, an alluvial plain about 50 miles wide and 400 miles long in the central part of California, stretching from just south of Bakersfield northward to Redding. The San Joaquin Valley makes up approximately the southern half of the Central Valley Province and is drained by the San Joaquin River. The Sacramento Valley makes up the northern half of the Central Valley Province and is drained by the Sacramento River. The San Joaquin River and its tributaries flow out of the Sierra Nevada Province into the Central Valley, depositing sediments on alluvial fans, in riverbeds, on floodplains, and on wetlands of the Central Valley Province. The Central Valley Province is characterized by alluvial deposits and continental and marine sediments deposited almost continually since the Jurassic Period (CGS 2002b). Quaternary age[2] alluvium is identified and mapped at the ground surface throughout the entire Project area and vicinity (Figure 11-1).

Alternating marine and continental deposits of Tertiary age underlie much of the Central Valley Province, including the San Joaquin Valley (Page 1986). The more recent Quaternary Period was characterized by continental sedimentary deposition. Tertiary and Quaternary continental formations in the San Joaquin Valley are composed of alluvial deposits of gravel, sand, silt, and clay and contain lenses of clay and silt comprising lacustrine, marsh, and floodplain deposits. These Tertiary and Quaternary deposits are of varying thickness, in some instances, thousands of feet thick (Page 1986). Continental formations (i.e., Mehrten, Kern River, Laguna, San Joaquin, Tulare, Tehama, Turlock, Riverbank, and Modesto Formations) make up the major aquifer(s) of the San Joaquin Valley (Ferriz 2001, Page 1986).

The San Joaquin Valley is a structural trough into which sediments have been deposited as much as 6 miles deep. Some of these sediments eroded from the Sierra Nevada and were transported and deposited in the Central Valley. Tectonic activity during the Tertiary Period strongly influenced the evolution of the Central Valley, alternately trapping water in the San Joaquin Valley or entire Central Valley to form inland seas that deposited marine sediments, and opening to allow drainage to the ocean, as under current conditions.

[2] The Quaternary Period, our current period in the geologic time scale, is divided into two epochs: the Pleistocene (2.588 million years ago to 11.7 thousand years ago) and the Holocene (11.7 thousand years ago to today).

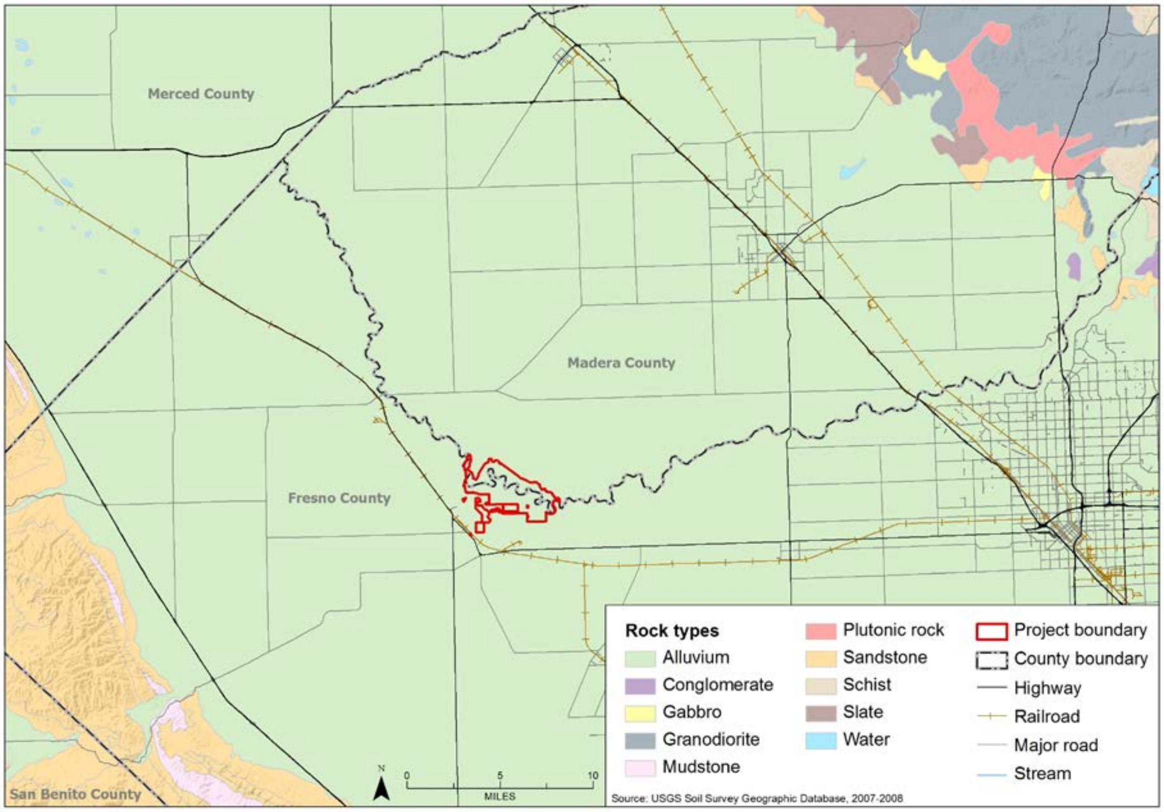


Figure 11-1.
Regional Geology

Surficial geology along Reach 2B is dominated by Holocene age alluvial deposits. These geologically young deposits cover the entire central San Joaquin Valley area. No bedrock is present on the ground surface. Sedimentary rock is exposed to the west in the Coast Ranges and igneous and metamorphic rocks are present in the Sierra Nevada to the east.

11.1.2 Soils

Soil development depends on parent material, climate, associated plants, topography, and age. Because these factors are similar within physiographic regions, soils within a physiographic region are often similar.

Soil Type

Valley Basin soils consist of organic soils, imperfectly drained soils, and saline and alkali soils in the valley trough and on the basin rims. Soils in the Project area are described as imperfectly drained and saline/alkali Valley Basin soils on the regional soil map (University of California Division of Agricultural Sciences 1980) (Figure 11-2).

The Valley Basin imperfectly drained soils generally contain dark clays, have a high water table, and are subject to overflow. These soils are found in the trough of the San Joaquin Valley, and consist in part of several thick lake bed deposits.

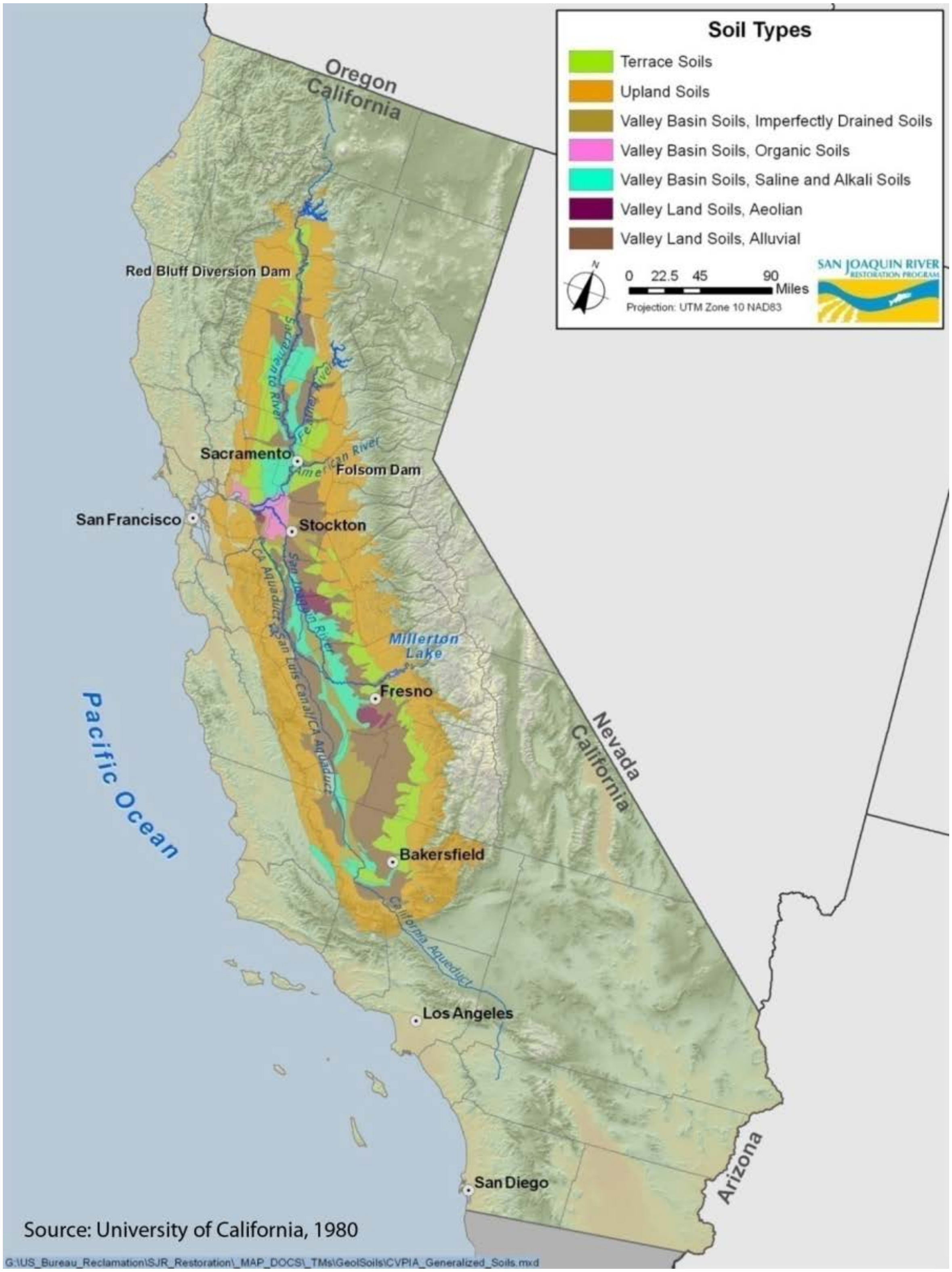


Figure 11-2.
Physiographic Soil Types in the Central Valley and Delta

The Valley Basin saline/alkali soils are characterized by excess salts (saline), excess sodium (sodic), or both (saline-sodic). In many of the older soil surveys, salinity and sodicity were jointly referred to as alkaline. A distinction was sometimes made because the saline soil many times formed a white crust on the surface and was called “white alkali,” and the soils with excess sodium appeared to be “black,” thus, black alkali. Both are fairly common throughout the San Joaquin Valley. In uncultivated areas, saline soils are used for saltgrass pasture and native range. Some of these soils support seasonal salt marshes. In areas of intermediate to low rainfall, these soils are saline-sodic. Many of these soils are irrigated with moderately saline Delta surface water, imported via the Delta-Mendota Canal (DMC), or with slightly saline groundwater. In addition, salts are added through application of fertilizers or other additives needed for cropping.

The accumulation of salts in the soils of the San Joaquin Valley is due to a combination of the regional geology, high water table, intensive irrigation practices, and the importation of water from the Delta that is moderate in salinity and application to lands in the region. The Corcoran Clay and other clay layers contribute to a naturally high water table in the valley, concentrating salts in the root zone by evaporation through the soil. Farmers actively leach these salts from the soil into drainage water with irrigation and subsurface drainage practices. Drainage water with high concentrations of salts may be reused for irrigation (with or without treatment), accumulate in groundwater, or be discharged to evaporation ponds or tributaries to the San Joaquin River. Salinization caused by concentrations of naturally-occurring soil salts is exacerbated by the use of more saline Delta water, imported via the DMC and California Aqueduct, as a major source of irrigation water.

Additionally, naturally occurring trace elements in soils may be mobilized and concentrated along with salts. Soils throughout the San Joaquin Valley typically contain some selenium, and soils on the west side of the valley are particularly selenium-rich. These soils have developed on alluvial deposits comprising eroded material from the Coast Range, where selenium is found in marine deposits. Selenium can pose a hazard to fish and wildlife when it becomes highly concentrated in surface waters.

A soil map of the Project footprint is shown on Figure 11-3 and the acreage of each soil type is presented in Table 11-1. The main soil types mapped in the area are Grangeville fine sandy loam, Chino fine sandy loam, and Chino loam (National Resources Conservation Service [NRCS] 2008). All of these soils are mixtures of sand, silt, and clay derived primarily from the weathering of granitic bedrock; the soils are differentiated based upon several soil properties such as amount of calcium carbonate or salt or organic matter content, for example. The primary use of soils within the Project area is for farming.

Table 11-1.
General Soils Data in the Project Footprint

Soil Type	Acreage
Cajon loamy sand	0.5
Calflax clay loam	3.0
Chino fine sandy loam	326
Chino loam	1,817
Chino sandy loam	105
Columbia fine sandy loam	7.4
Columbia loamy sand	98
Columbia soils	19
Dello sandy loam	64
Elnido sandy loam	51
Foster loams	1.8
Grangeville fine sandy loam	1,663
Grangeville sandy loam	158
Merced clay	8.2
Palazzo sandy loam	31
Posochanet clay loam	2.5
Riverwash	69
Tachi clay	358
Tranquillity clay	81
Traver fine sandy loam	7.5
Traver loam	60
Traver sandy loam	14
Tujunga loamy sand	396
Visalia fine sandy loam	16
Visalia sandy loam	21
Water	448
Wunjey very fine sandy loam	97
Total Acreage	5,922

Source: NRCS 2008

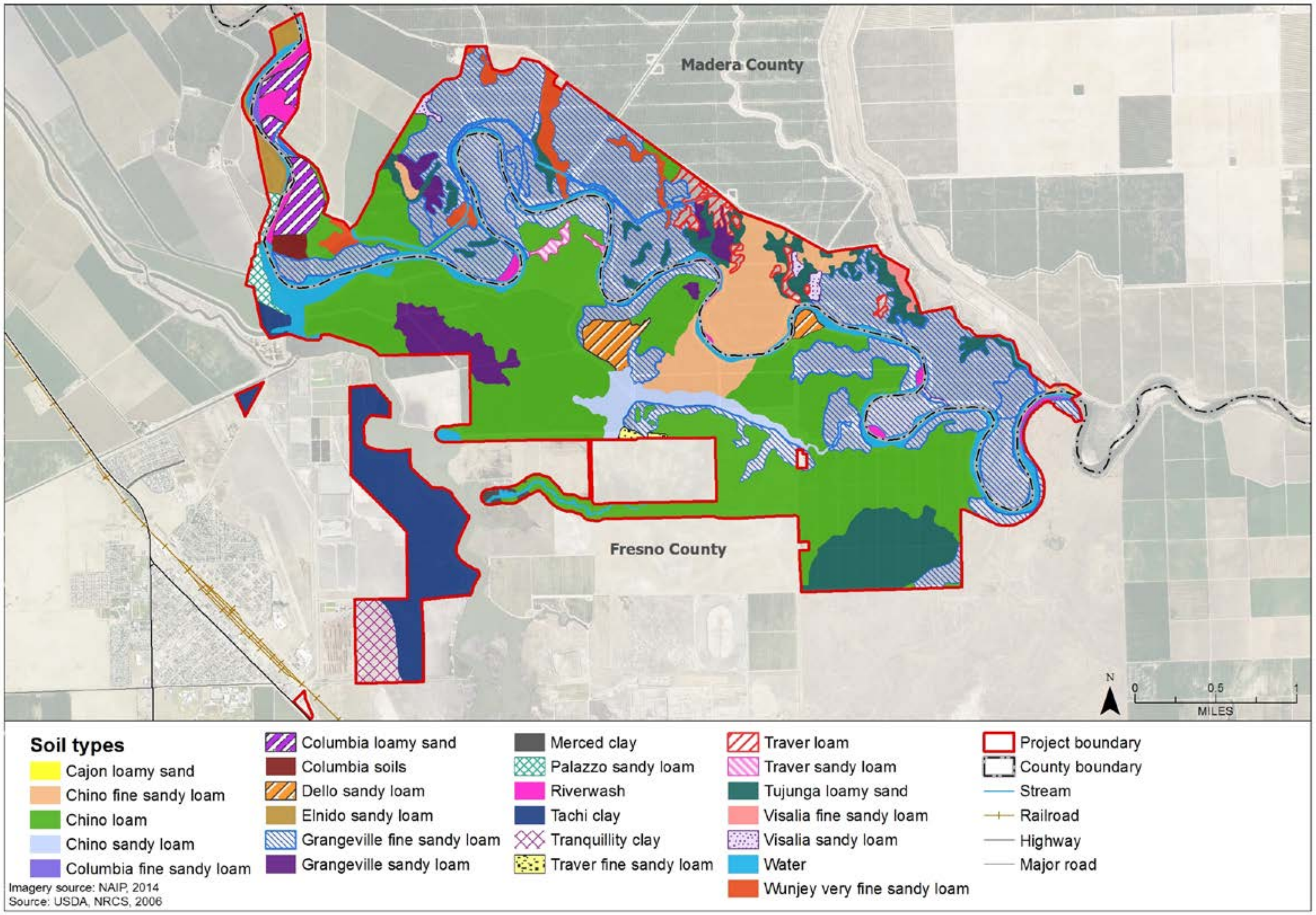


Figure 11-3.
General Soils Type in the Project Footprint

Generalized Soil Texture

Soils and sediments in the Project area and vicinity are composed of a heterogeneous mix of recent river channel deposits, recent floodplain deposits, and older deposits. The texture of these sediments ranges from coarse-grained gravels to fine-grained clays, and the distribution of these textures can have a strong influence on the hydrogeology of the underlying aquifer system. Table 11-2 contains the calculated areas in acres for each generalized soil texture in the Project area. Soils are predominantly classified as sandy loam and loam.

Table 11-2.
Acreages of Soil Textures in Project Footprint

Soil Texture	Acreage
Clay/Clay Loam	453
Loam	1,879
Loamy Sand	494
Sandy Loam	2,560
Variable[1]	536
Total Acreage	5,922

Source: NRCS 2008

Note:

[1] The category "variable" includes soils of undifferentiated texture and areas that were not mapped by the National Resources Conservation Service (i.e., areas covered by water during the mapping period).

Levee seepage has been a concern in the Project area and vicinity. Under-seepage, water that seeps laterally by travelling under a dam or levee section, can occur when structures are underlain by permeable native soils. Movement of water through or underneath levees, commonly appearing as boils or piping (seeps), may saturate the levee or transport foundation materials and compromise the short- or long-term integrity of the levee. Levee seepage can also raise groundwater surface elevations in adjacent areas, thereby increasing soil saturation and potentially reducing crop yields and/or increasing crop mortality.

11.1.3 Erosion and Sedimentation

The sediment load of the San Joaquin River and its tributaries originates from the erosion of soil and rock in the watershed. The sediment load of the San Joaquin River, like most rivers, generally becomes finer grained with distance downstream.

Soil Erosion Potential

Soil erosion is a natural physical process of wearing away and transport of soil materials by wind, water, ice, and gravity. Erosion can remove soils, undermining structures like bridges, and can lead to unstable steep slopes. Erosion is followed by deposition of the eroded materials, typically in low-lying areas, causing sedimentation of streams and reservoirs. Erosion also can result in landslides that may damage roads, buildings, and other infrastructure. Soil characteristics that affect the erosion rate are soil surface texture and structure, particle size, permeability, infiltration rate, and the presence of organic or other cementing materials. Other key factors determining erosion potential are the extent of vegetation, type of cover (vegetative or otherwise), human or other disturbance, topography, and rainfall.

Human activities can also effectively accelerate natural erosion processes. Localized sedimentation problems can occur with construction and development or agricultural activities, which usually involve vegetation removal, compaction of porous soils, and concentrated drainage from large areas. Improper agricultural management practices can accelerate erosion. Overgrazing and land clearing, particularly on steep slopes, but also on flat areas, make surfaces vulnerable to topsoil loss. Elevation measurements made from 1922 to 1981 indicate that even typical agricultural practices, regardless of crop type, may cause up to 1 to 3 inches of soil loss per year (Rojstaczer et al. 1991).

Infrastructure Effects on Sediment Transport

A significant effect of dams and water storage reservoirs on a watershed is on sediment supply because they serve as impediments to downstream sediment transport. Because of the slowing of stream flow velocity in the reservoir, sediment settles out of the water column and onto the reservoir bottom. Although the water and some of its fine sediment may be released on the downstream side of the dam, the majority of the sediment load, particularly the coarser materials (gravel, sand, and some silt), remains on the upstream side. Friant Dam stops most of the sediment from the upper San Joaquin River watershed from moving downstream. Reservoirs also create a transport-limited system downstream of the dam by reducing the frequency and/or intensity of natural high-flow regimes that were prevalent prior to dam construction. This limits gravel mobility and promotes bed coarsening/bed armoring.

Under unaltered conditions, fluvial processes, including sediment transport, are naturally adjusted along the length of a river to match the channel gradient, stream discharge, and sediment load. Flow energy in the river channel is dissipated gradually. Bridges and culverts constrict the natural channel and disrupt these processes. This may occur at high and/or low flows, depending on the size of the structure.

Effects of channel constrictions caused by bridge and culvert crossings include the following:

- Sediment deposition upstream from the constriction (backwater effects).
- Scour at the constriction due to an elevated water surface and increased water velocity.
- Sediment deposition downstream from the constriction due to flow expansion, leading to the formation of splay bars.
- Reduced flood conveyance capacity due to filling in of floodplain space when building bridge and culvert abutments.
- Catastrophic erosion of bridge or culvert crossing (and possibly surrounding areas) during large storm events due to channel blockage at constriction by debris such as trees, bushes, or other natural or man-made materials.

The function and operation of the water supply and flood control infrastructure present in the Project area and vicinity also affect fluvial processes of the San Joaquin River. Such infrastructure includes diversion structures, bypasses and bypass diversions, other hydraulic control structures, off-stream flood control dams, levees, and canals. These structures divert base flows and/or flood flows and constrict flood flows and thereby significantly alter fluvial processes. The processes most affected are sediment transport, local incision and deposition, and channel migration (Table 11-3).

Table 11-3.
Generalized Effects on Geomorphic Processes of Major Flood Control and Water Supply Infrastructure

Infrastructure	Effects
Diversion structures	Backwater effects cause disruption of local incision and deposition patterns; riprap protection prevents channel migration and avulsion; reroute sediment load
Bypasses	Reroute sediment load within the Project area
Bypass diversion structures	Backwater effects cause disruption of local incision and deposition patterns; reroute sediment load within the Project area
Other hydraulic control structures	Backwater effects cause disruption of local incision and deposition patterns; reroute sediment load within the Project area
Offstream flood control dams	Reroute sediment load within the Project area and vicinity
Levees	Dissect the historic floodplain, stop channel migration and avulsion, increase river velocity and, thus, also increase incision, bed armoring, and channel simplification
Canals	Embankments dissect the historic floodplain, stop channel migration and avulsion, increase river velocity and, thus, also increase incision, bed armoring, and channel simplification; reroute sediment load

Sediment load is carried by stream flow, and infrastructure that reroutes these flows alters sediment transport. Levees and canal embankments, especially those that are constructed within the floodplain and not sufficiently set back from the channel, dissect the historic floodplain preventing channel migration and avulsion.[3] This prevents oxbow formation and also increases river velocity, which encourages channel incision, bed armoring, and channel simplification.

Specific flood control and water supply infrastructure in the Project area and its effects on sediment transport are discussed below.

Local Erosion and Sedimentation

With the combination of agricultural development, reduction of the high-flow regime under controlled releases from Friant Dam, construction of levees, and incorporation of flood control structures with bypass channels, such as the Chowchilla Bypass, the river channel became simplified. High-flow scour channels were eliminated, the main channel footprint was reduced, and side channels were cut off from the main river. Prior to

[3] Avulsion is the rapid abandonment of a river channel and the formation of a new river channel.

implementation of Interim Flows, most sediment was routed through the Chowchilla Bypass and very little sediment moved through Reach 2B. Instead, most sediment was routed with flows into the bypass, or accumulated in sand traps immediately upstream of the bypass.

Historically, when flows through Reach 2 were more consistent, sediment supply and transport capacity decreased gradually from Reach 1B through Reach 2 as sediment was deposited on the floodplain and multiple side channels evolved across the floodplain. This is demonstrated by the presence of remnant channel deposits and relic floodplain features.[4] As water infrastructure was built in Reach 2B, sediment transport was affected. Small diversion structures, like Mendota Dam, affect sediment transport by modifying the delivery of sediment downstream. The culvert at the San Mateo Avenue crossing is a constriction in the stream channel during low stream flows, which can cause backwater, scour, and deposition. At higher discharge levels, the culvert becomes overwhelmed and the river flows over the crossing.

Lack of vegetation and the sandy substrate would cause the riverbed to be easily eroded when flows pass through the reach. Bed mobility can occur at most baseflows, and bed scour could occur throughout the reach at moderate to high flows. As a result of this erosion, channel avulsion and migration could occur between the levees if the levees were not constraining the channel. The river banks are another area where soil erosion is occurring in the Project footprint and are likely areas where soil erosion would occur in the future. U.S. Geological Survey (USGS) data (USGS 2007 and 2008) indicate that soils, primarily on the left bank, may be highly erodible (Figure 11-4).

11.1.4 Geomorphology

The San Joaquin Valley floor is divided into several geomorphic land types, including dissected uplands, alluvial fans and plains, river channels and floodplains, and overflow lands and lake bottoms. The alluvial plains cover most of the valley floor and make up some of the intensely developed agricultural lands in the San Joaquin Valley. River floodplains and channels lie along the major rivers and to a lesser extent the smaller streams that drain into the valley from the Sierra Nevada. Some floodplains are well-defined where rivers incise their alluvial fans. These deposits tend to be coarse and sandy in the channels and finer and silty in the floodplains. Lake bottoms of overflow lands include historical beds of Tulare Lake, Buena Vista Lake, and Kern Lake as well as other less defined areas in the valley trough.

The Project footprint extends downstream from the Chowchilla Bifurcation Structure to about 2 miles below Mendota Dam. The lack of confining features and the reduced gradient in Reach 2B both cause the channel to change to sand-bedded, meandering morphology. Meanders become more sinuous in Reach 2B than upstream as the river runs up against the alluvial deposits of the Coast Range drainages. This is also the point of diversion for the Chowchilla Bifurcation Structure, which, prior to Interim Flows, diverted most of the flows that enter Reach 2B into the Chowchilla Bypass. Lone Willow

[4] Relic floodplain features, which have coarser sediment than the adjacent floodplain, may provide a lateral conduit for levee seepage.

Slough is a historical side channel that begins near the Chowchilla Bifurcation Structure and terminates in Reach 3. Today, this channel carries riparian diversions for irrigation, agricultural return flows, and runoff.

The river slope in Reach 2B decreases to 0.00022 or about 1 foot per mile, which is almost a factor of 2 less than the slope in Reach 2A. The median bed material diameter is approximately 0.026 inches (Mussetter Engineering, Inc. 2002). Currently, water operations allow a maximum flow of approximately 810 cubic feet per second (cfs) in this reach with all excess flow diverted into the Chowchilla Bypass. The geomorphology of Reach 2B is discussed in depth in Chapter 14.0, "Hydrology – Surface Water Resources and Water Quality."

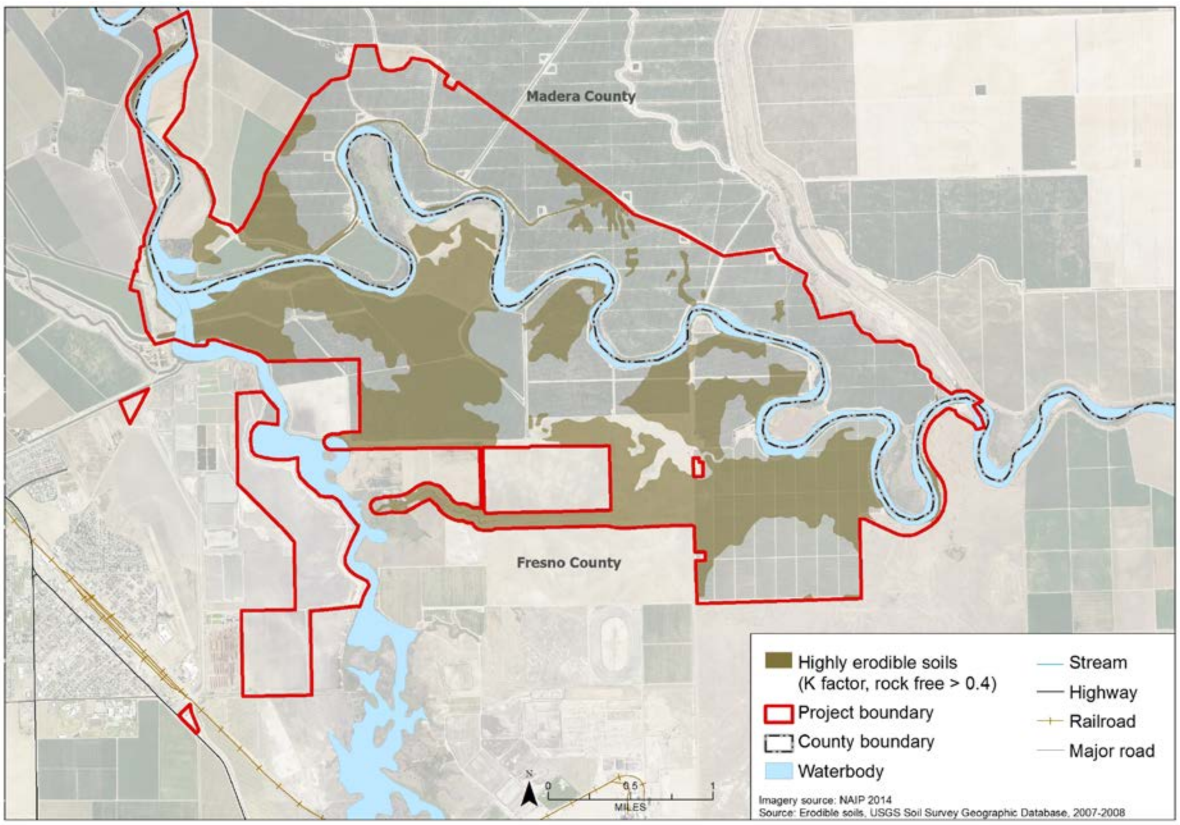


Figure 11-4.
Erodible Soils in the Project Footprint

11.1.5 Soil Hazards

Reach 2 soils have natural selenium content. According to a soil survey from the mid-1980s, soils in the upper portion of the Project footprint contain 0.10 to 0.13 parts per million (ppm) of selenium in the top 12 inches of soil. The lower portion of the Project footprint contains 0.14 to 0.36 ppm selenium in the top 12 inches of soil (San Joaquin Valley Drainage Implementation Program [SJVDP] 1990). Data collected more recently from Mendota Pool found selenium concentrations in sediments up to 0.95 ppm, but aqueous concentrations in soil elutriate were less than 3 parts per billion (ppb) which is below the aquatic life criteria of 5 ppb (San Joaquin River Restoration Program [SJRRP] 2012). The presence of selenium can affect surface water quality and is discussed in Chapter 14, “Hydrology – Surface Water Resources and Water Quality.”

Soil corrosivity involves the measure of the potential of corrosion for steel and concrete caused by contact with some types of soil. Knowledge of potential soil corrosivity is often critical for the effective design of cathodic protection of buried steel and concrete elements. Factors including soil composition, soil chemistry, moisture content, and pH affect the response of steel and concrete to soil corrosion. Soils with high moisture content, high electrical conductivity, high acidity, or high dissolved salts content are most corrosive. In general, sandy soils have high resistivities and are the least corrosive. Clay soils, including those that contain interstitial salt water, can be highly corrosive.

Figure 11-5 indicates that the soils in the Project footprint generally have low corrosivity to buried concrete elements except in the Fresno Slough area were soils are moderately corrosive to concrete. Figure 11-6 shows that the soils generally have high corrosivity to buried steel.

Expansive soils are those that undergo a significant increase in volume during wetting, and shrink in volume as they decrease in water content, also known as shrink-swell soils. Expansive soils can cause significant damage to structures due to increases in uplift pressures. Soils are generally classified as having low, moderate, and high expansive potentials. Soils containing a high percentage of clay types particularly susceptible to expansion usually have high expansive potentials, and more granular sands and gravels generally have low expansive potential. Figure 11-7 shows that nearly all of the soils within the Project footprint have low shrink-swell potential. The southwest portion of the site west of Fresno Slough has very high shrink-swell potential.

11.1.6 Mineral Resources

In 2006, California ranked third in the nation in nonfuel mineral production. In that year, California yielded $4.6 billion in nonfuel minerals, totaling 7 percent of the Nation’s entire production (Kohler 2006). Of these products, construction sand and gravel are the most widely mined resources in the vicinity of the San Joaquin River. Historically, gold was also extracted from the riverbed.

Sand, Gravel, and Other Rock Products

In 2006, California was the Nation’s largest producer of construction sand and gravel ($1.5 billion) and Portland cement ($1.25 billion) (Kohler 2006). California also produced significant quantities of crushed stone ($481 million), industrial sand and gravel ($62.2 million), masonry cement ($87.8 million), and dimension stone ($11.2 million). Together, the market value of these products total $3.4 billion, almost 75 percent of the total value of State nonfuel mineral production. The San Joaquin River below Friant Dam is a significant source of sand and gravel in the State, and mining occurs at multiple locations on the floodplain and river terraces upstream of the Project area (Mussetter Engineering, Inc. 2002). One aggregate mine is present near the downstream limit of the Project footprint (Figure 11-8) (California Department of Conservation, Office of Mine Reclamation 2011).

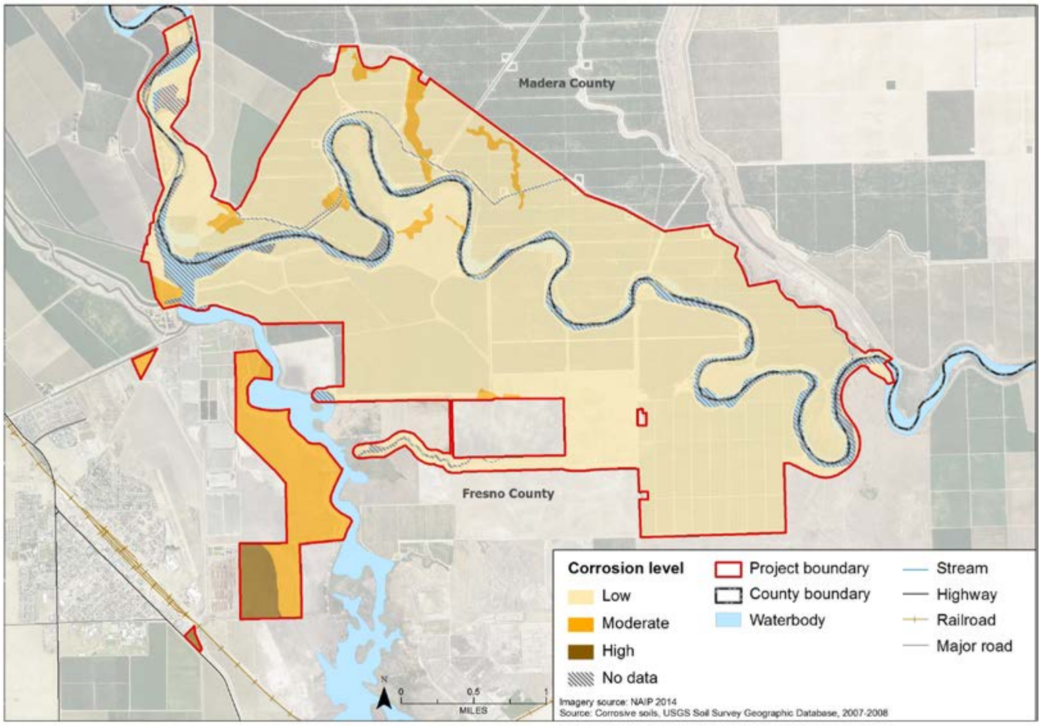


Figure 11-5.
Corrosion Level of Soils to Concrete in the Project Footprint

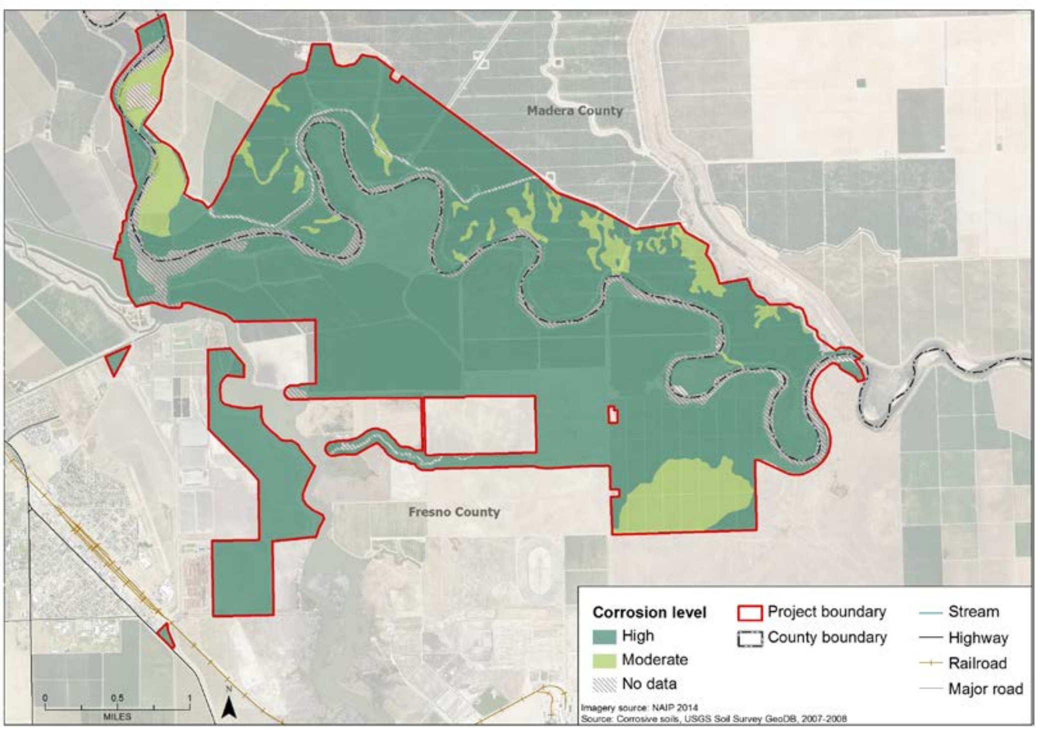


Figure 11-6.
Corrosion Level of Soils to Uncoated Steel in the Project Footprint

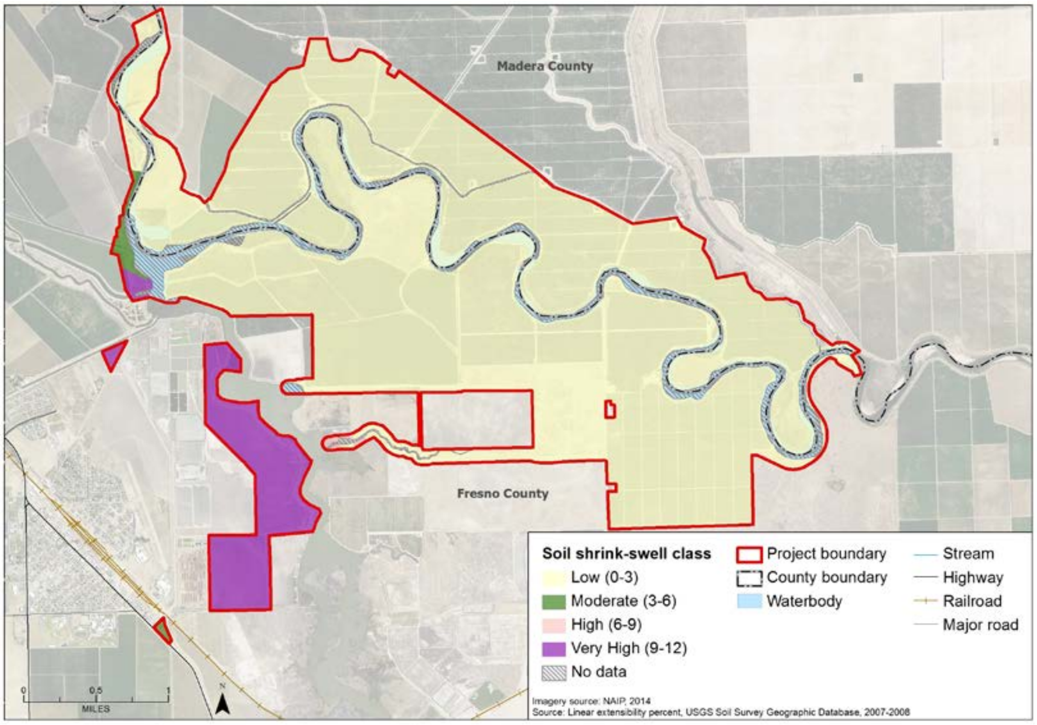


Figure 11-7.
Soil Shrink-Swell Classes in the Project Footprint

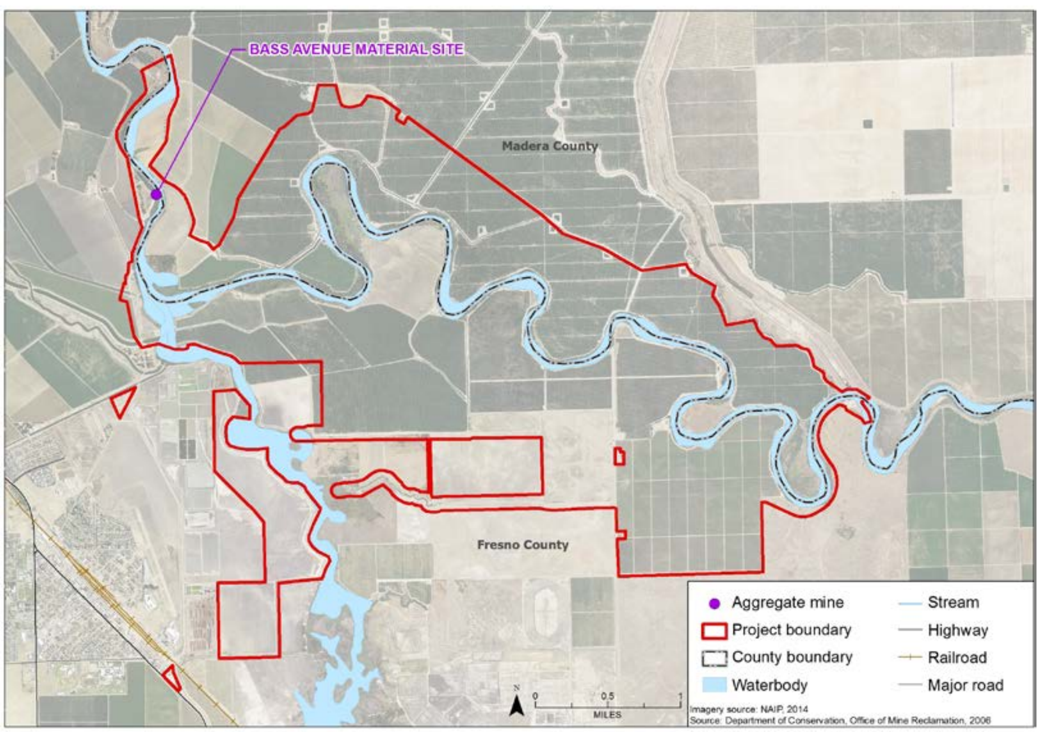


Figure 11-8.
Aggregate Mines in the Project Footprint

Gold

Gold has been mined from placer deposits in loosely consolidated alluvial sediments throughout the Sierra Nevada foothills. The San Joaquin River above Friant Dam was subject to some degree of placer mining from 1848 to 1880, followed by dredge mining from 1880 to the 1960s (Mussetter Engineering, Inc. 2002). These activities significantly reworked the riverine environments, redistributing sediments and altering channel forms. However, the San Joaquin River was less affected by dredge mining than the more northerly Sierra Nevada drainages, where gold was more plentiful (McBain and Trush 2002). Aside from recreational gold mining that has been observed to occur near the town of Friant, gold extraction does not currently occur on any part of the San Joaquin River.

Oil and Natural Gas

The San Joaquin Valley is one of the largest sources of oil in California, although most of the oil wells are south of the Project area. Figure 11-9 shows nearby oil fields. None are within the Project footprint.

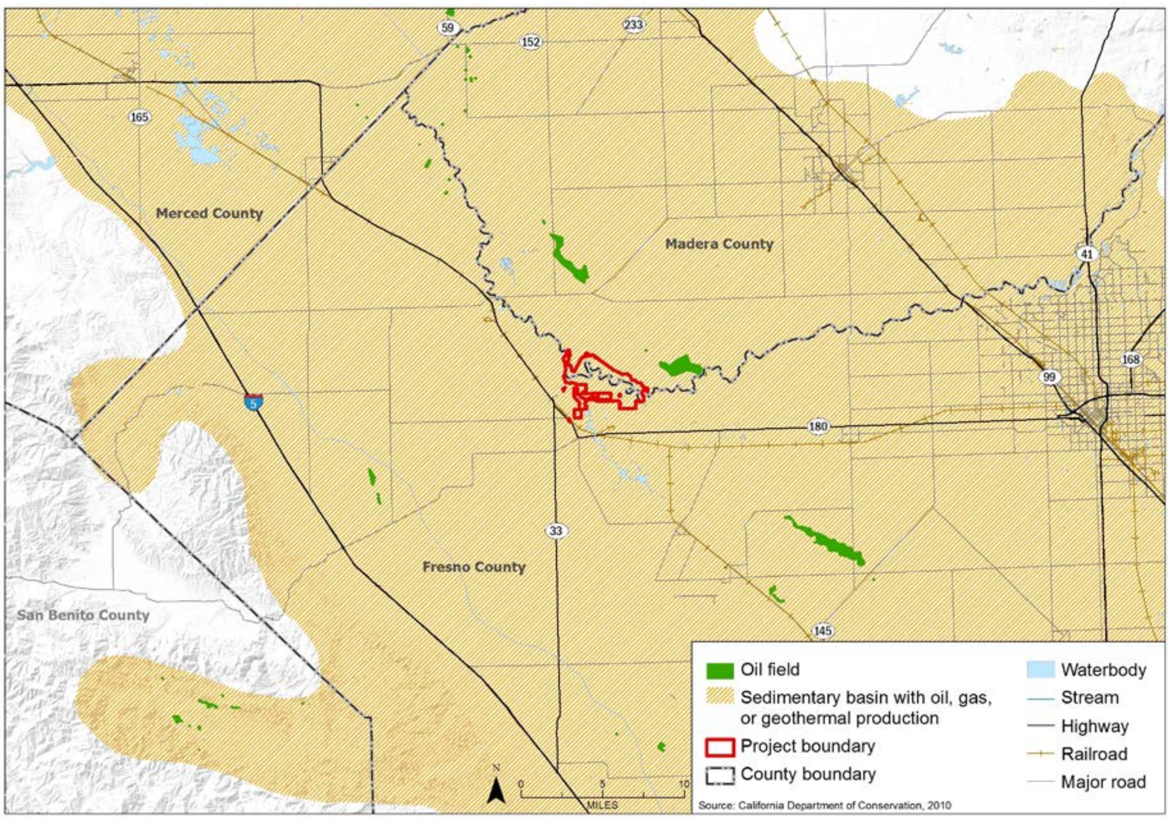


Figure 11-9.
Oil and Gas Fields in the Project Area and Vicinity

Local Mining

Local landowners perform some sand mining near the river channel, leaving pits 10 to 15 feet deep. The pits appear to fill after a single flood control release from Friant Dam. As stated above, one aggregate mine is present in the Project footprint near the downstream end below Mendota Pool (Figure 11-8). No gold is mined in the Project area.

11.1.7 Seismicity and Neotectonics

Both the Sierra and Central Valley geologic provinces continue to be subject to minor tectonic activity. Locally, normal faults are found in the Sierra Nevada foothills, probably because the west, or valley, side of the Sierra block is subsiding faster than uplift of the east side (Bartow 1991). The closest faults of the Foothills Fault System are located about 40 miles north of the Project area and the closest fault strands with activity within the last 700,000 years are more than 70 miles to the north (Jennings and Bryant 2010).

San Joaquin Valley Deformation and Subsidence

Regional deposition and deformation patterns of sediments in the San Joaquin Valley have been strongly controlled by recent tectonic activity (Bartow 1991). Quaternary deposits in the San Joaquin Valley are deformed into a broad, asymmetrical trough with its axis 12 to 19 miles west of the current course of the San Joaquin River (Lettis and Unruh 1991). Subsidence is probably due in part to the uplift and tilting of the Sierran block to the east and the Coast Ranges to the west, although the rate of valley subsidence is higher than that of Sierran uplift. Valley subsidence may also be due to sediment loading and compressional down warping or thrust loading from the Coast Ranges (Lettis and Unruh 1991).

Valley subsidence is also known to be occurring in some areas because of groundwater pumping, hydrocompaction, pumping from oil and gas fields, and oxidation of soils with high organic content. Of these factors, aquifer-system compaction by groundwater pumping has caused the largest magnitude and areal extent of land subsidence in the San Joaquin Valley (Sneed et al. 2013). Recent subsidence rates in the Restoration Area range from about 0.15 foot per year to 0.75 foot per year, as calculated from survey data collected between December 2011 and December 2015 (Reclamation 2016).

Total subsidence near Mendota Pool reached nearly 9 feet by 2001 as compared to 1935 levels. Subsidence rates were greatest in the 1950s, with an average rate for areas near Mendota Pool of 4.4 inches per year, between 1953 and 1957. Subsidence rates near Mendota Pool were reduced in the 1990’s and 2000’s with rates averaging 0.44 inch per year between 1997 and 2001 and 0.04 inch per year between 2003 and 2008 (Sneed et al. 2013). More recently, subsidence rates in the Project area ranged from about 0 to 3.6 inches per year, as calculated from survey data collected between December 2011 and December 2015 (Reclamation 2016). Subsidence rates vary annually, with higher rates occurring during critical dry conditions when the river is dry and when groundwater pumping is likely to increase. For example, average subsidence rates in the Project area were 0.15 to 0.3 foot per year in 2015 during critical dry conditions. Subsidence rates in Reach 2B are generally lower than rates found in Reach 4B and the Eastside Bypass due in part to continuous infiltration of surface water at Mendota Pool. (Subsidence is also discussed in Chapter 13.0, “Hydrology – Groundwater” and Chapter 14.0, “Hydrology - Surface Water Resources and Water Quality.”)

Seismicity

Active faults are recognized on the west side of the San Joaquin Valley (Figure 11-10). Most of these faults are part of a series of buried thrust faults (blind faults) that separate the Central Valley from the Coast Ranges. The Great Valley thrust system comprises at least 14 segments over a length of more than 300 miles, although precise locations of surface traces are not well documented because these faults do not rupture to the surface (USGS 1996). The Great Valley thrust system is thought to accommodate a nominal 0.02 to 0.06 inch per year of motion (CGS 2002c, USGS 1996). The closest segment to the Project area is the Panoche Segment, Great Valley Segment 10, which is located about 19 miles to the southwest (Figure 11-10).

Seismicity in the Project area and vicinity is dominated by ground shaking related to movement on the buried thrust faults mapped along the west side of the San Joaquin Valley that separate the Sierran Block from the Coast Ranges block (Figure 11-10). The closest of these faults is about 19 miles to the southwest. Therefore, surface fault rupture is not a significant hazard for the Project area. Figure 11-11 shows historic earthquake epicenters in this part of California. No earthquakes with a magnitude greater than 6.0 have occurred within about 38 miles of the site. Figure 11-12 shows that the calculated peak horizontal ground acceleration that has a 2 percent probability of exceedance in 50 years is 0.3 to 0.4 g (expressed as a fraction of the acceleration due to Earth's gravity). The horizontal acceleration pattern shown reflects movement on Coast Ranges faults.

Ground Shaking and Liquefaction Hazards

Although a fault rupture can cause significant damage along its narrow surface trace, earthquake damage is mainly caused by strong, sustained ground shaking (Working Group on California Earthquake Probabilities [WG02] 2003). Seismic ground shaking can cause soils and unconsolidated sediments to compact and settle. If compacted soils or sediments are saturated, pore water pressure increases during earthquake shaking and water can be forced upward to the ground surface, forming sand boils or mud spouts. Increased pore pressures also lead to a reduction in shear strength of the sediments such that they may behave like a viscous fluid. This soil deformation, called liquefaction, may cause minor to major damage to buildings and infrastructure. Earthquake ground shaking hazard potential is low in most of the San Joaquin Valley and Sierra Nevada foothills (California Seismic Safety Commission [CSSC] 2003). Although the San Joaquin Valley is not considered to be a high-risk liquefaction area because of its generally low earthquake and ground shaking hazard risk, it can be assumed that some liquefaction risk exists throughout the valley in areas where unconsolidated sediments and a high water table coincide, such as near rivers and in wetland areas (Merced County 2007).

Hazard Due to Dam Break Inundation

The entire Project area and surrounding portion of the central San Joaquin Valley are in an area of potential inundation if either Friant or Pine Flat dams fail (Figure 11-13).

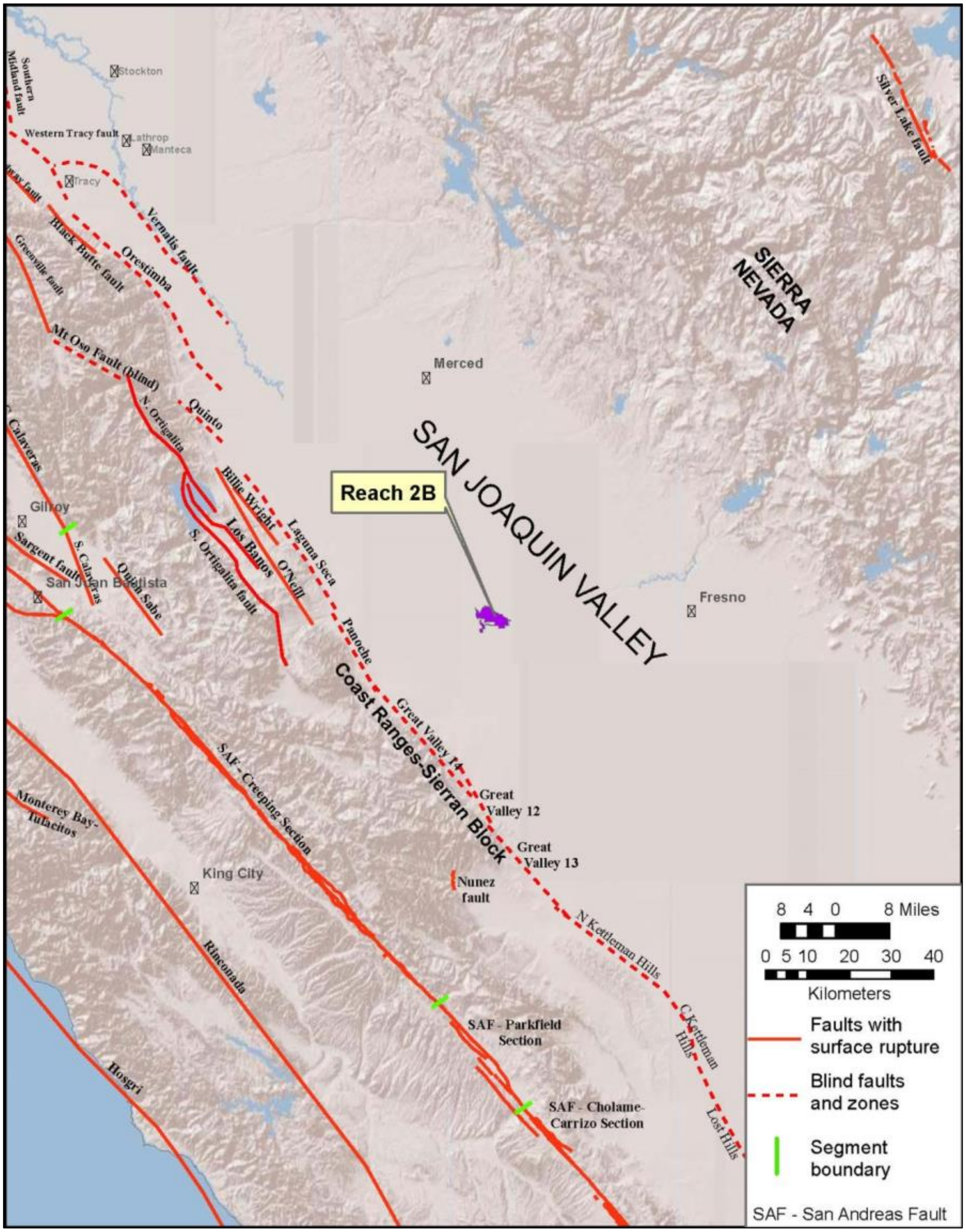


Figure 11-10.
Active Faults in the Project Area and Vicinity

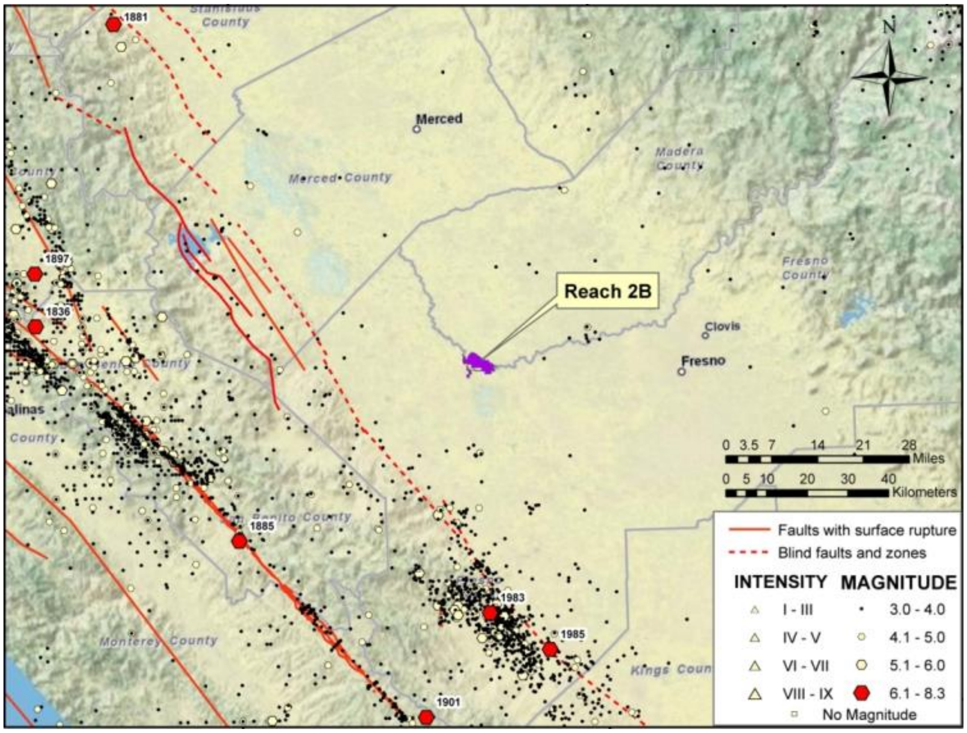
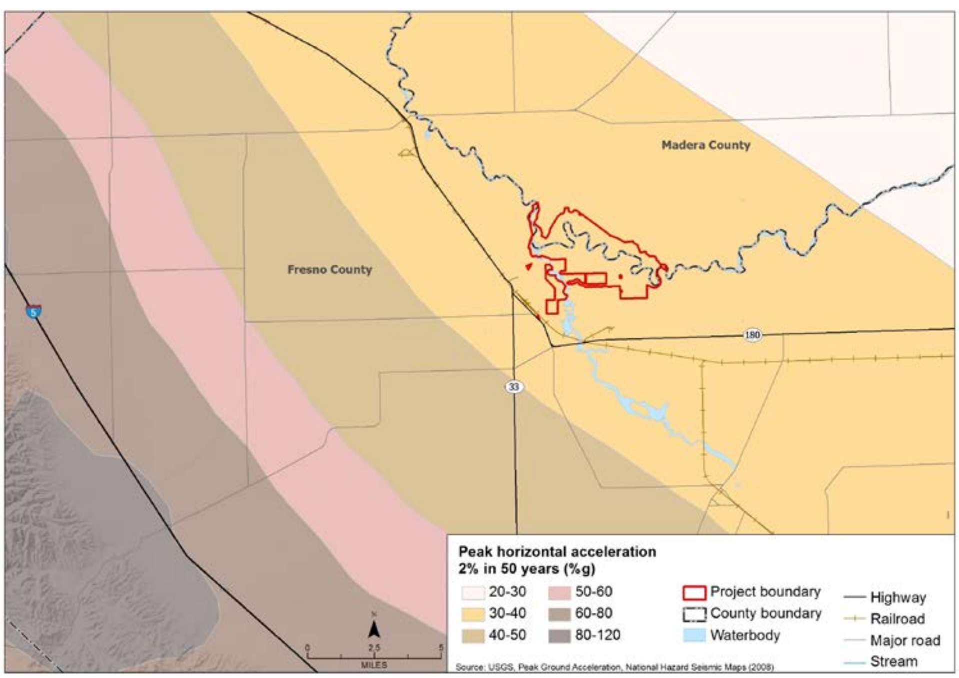


Figure 11-11.
Active Faults and Historical Seismicity in the Project Area and Vicinity (M>= 3.0) 1800-2009



Note: 2 percent probability of exceedance in 50 years

Figure 11-12.
Calculated Peak Ground Acceleration in the Project Area and Vicinity

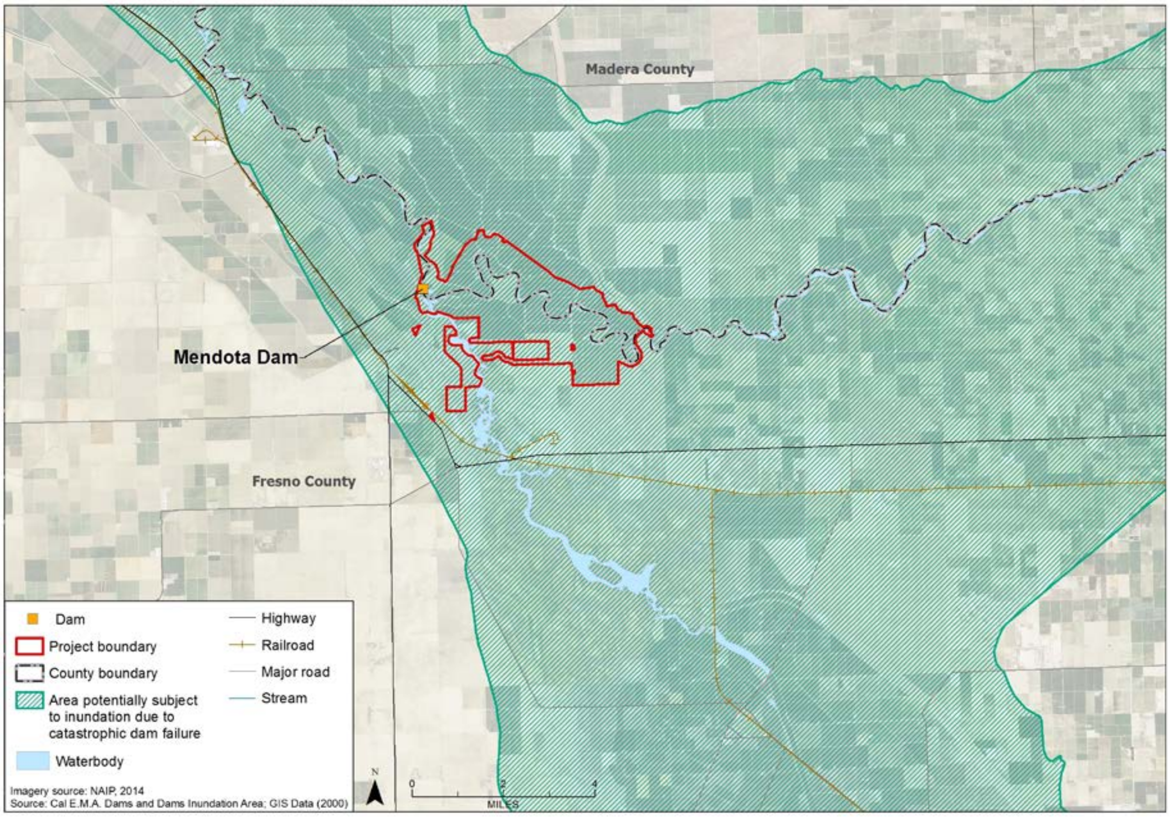


Figure 11-13.
Inundation in the Project Area and Vicinity due to Catastrophic Dam Failure

11.2 Regulatory Setting

This section presents applicable Federal, State, and local laws and regulations associated with geology and soils in the Project area.

11.2.1 Federal

Federal regulations associated with geology and soils in the Project area include the Clean Water Act (CWA) and National Pollutant Discharge Elimination System (NPDES) program, as well as the National Flood Insurance Program, which regulates construction of levees and other flood-related activities.

Clean Water Act Section 402

(See Chapter 14.0, “Hydrology - Surface Water Resources and Water Quality.”) CWA Section 402 is directly relevant to excavation and grading activities that may occur during restoration and other activities which may affect geology and soils in the Project area.

National Flood Insurance Program Regulations

(See Chapter 12.0, “Hydrology – Flood Management.”) Criteria in 44 Code of Federal Regulations (CFR) 65.10 apply to Mapping of Areas Protected by Levee Systems and to standards for levee design and performance.

11.2.2 State of California

Several codes and acts are in place in the State that may pertain to activities affecting geology and soils in the Project area.

Alquist-Priolo Earthquake Fault Zoning Act

California's Alquist-Priolo Earthquake Fault Zoning Act (Pub. Resources Code, § 2621 et seq.), originally enacted in 1972 as the Alquist-Priolo Special Studies Zones Act, and renamed in 1994, is intended to reduce the risk to life and property from surface fault rupture during earthquakes. The Alquist-Priolo Act prohibits the location of most types of structures intended for human occupancy across the traces of active faults, and strictly regulates construction in the corridors along active faults (earthquake fault zones). However, no active faults are mapped within the Project area (Jennings and Bryant, 2010).

California Building Standards Code

California's minimum standards for the design and construction of buildings, associated facilities, and equipment are given in the California Code of Regulations. Many of the applicable standards are found in the California Building Standards Code (Cal. Code Regs., tit. 24); other standards applicable to buildings are given in Titles 8, 19, 21, and 25 of the California Code of Regulations. Design and construction must satisfy these requirements.

Surface Mining and Reclamation Act

The California Surface Mining and Reclamation Act of 1975 (SMARA) (Pub. Resources Code, § 2710 et seq.) addresses surface mining. Activities subject to SMARA include, but are not limited to mining of minerals, gravel, and borrow material. SMARA applies to an individual or entity that would disturb more than 1 acre or remove more than 1,000 cubic yards of material through surface mining activities, including the excavation of borrow pits for soil material. SMARA also mandated that the State Geologist make an inventory, by county, of mineral resources of statewide and regional significance.

11.2.3 Regional and Local

Local policies and plans in the Project area may relate to implementation of project alternatives potentially affecting geology and soils.

County General Plans

As required by state law, counties in the Project area have developed their own general plans. At a minimum, these documents must address the topics of land use, transportation, housing, conservation, open space, noise, and safety. These documents serve as statements of county goals, policies, standards, and implementation programs for the physical development of a county.

Fresno County General Plan

The Fresno County General Plan Policy Document (Fresno County 2000) outlines several policies for geological resources and/or geological hazards.

- Policy OS-J.9 requires that the location of significant geological resources is considered prior to approval of new development.
- Policy HS-D.3 requires that a soil engineering and geologic-seismic analysis is performed in areas prone to geologic or seismic hazards.
- Policy HS-D.4 requires that structures are designed in accordance with relevant professional standards to minimize damage or loss and to minimize risk to public safety.

Madera County General Plan
The Madera County General Plan Policy Document (Madera County 1995) outlines several policies for geological resources.

- Policy 5.G.1 protects geological resources from incompatible development.
- Policies 6.A.1 to 6.A.4 address seismic and geological hazards.

11.3 Environmental Consequences and Mitigation Measures

11.3.1 Impact Assessment Methodology

The analysis presented in this section is qualitative and based on the general information on geology, soils, mineral resources, seismicity and neotectonics, and geomorphology documented for the region, as previously described. The analysis is also based on a review of published geologic and soils information for the Project area, and professional judgment, in accordance with the current standard of care for geotechnical engineering and engineering geology. The evaluation of impacts on geologic and soil resources considers how proposed changes associated with Project alternatives would affect these resources in Reach 2B.

Impacts to geologic and soil resources that could result from Project construction and operation were evaluated qualitatively based on expected construction practices, materials, locations, and duration of Project construction and related activities, as well as project operations including the effects of modified San Joaquin River flows. The potential loss of geologic and soil resources resulting from implementation of Project alternatives is also evaluated qualitatively. The effect of the Project on the San Joaquin River fluvial geomorphology including bank erosion, channel migration, sedimentation, scour, and changes in the river channel substrate are addressed in Chapter 14, “Hydrology - Surface Water Resources and Water Quality.”

Site geology has been evaluated to identify the potential for adverse effects resulting from failure of engineered structures, such as dams, levees, and bifurcations, caused by adverse geologic conditions. The following geologic and soil conditions could affect engineered structures that are part of the Project:

- Unsuitable geologic foundation materials, including compressible soils, expansive soils, and levee under-seepage.
- Erosion of soils from around and beneath structures and their foundations.

- Seismic conditions, including fault rupture, strong ground motion, seismic-induced liquefaction, lateral spreading, settlement, and slope failure.

Impacts to existing infrastructure caused by adverse geologic conditions exacerbated by implementation of the Project were also evaluated qualitatively.

Consistent with the general program-wide design strategies identified in the SJRRP, the analysis assumes the following:

- A geotechnical and engineering geologic study would guide the final site-specific design.
- Earthwork would be designed and conducted in accordance with all relevant requirements of U.S. Department of the Interior, Bureau of Reclamation (Reclamation) design standards including Design Standards No. 3, Chapter 12, General Structural Considerations.
- All structures would be designed consistent with Reclamation design standards or equivalent standards, for example U.S. Army Corps of Engineers (Corps) engineering design standards EM 1110-2-2000 Concrete for Civil Works Structures, EM 1110-2-2100 Stability Analysis of Concrete Structures, EM 1110-2-2705 Structural Design of Closure Structures for Local Flood Protection Projects.
- Expansive soil hazards can be addressed through overexcavation and replacement with nonexpansive fill, amendment, or other measures consistent with Reclamation design standards.
- Corrosive soil hazards can be addressed by overexcavation and replacement with noncorrosive fill, by use of corrosion-protected materials, or by other measures consistent with Reclamation design standards.
- Construction would proceed in accordance with requirements of a Stormwater Pollution Prevention Plan (SWPPP).
- Post-construction soil erosion hazard would be addressed by overexcavation and replacement with non-erosive engineered fill, or by the use of geosynthetics, vegetation, riprap, or other suitable measures consistent with Reclamation design standards.

11.3.2 Significance Criteria

The Project is evaluated in accordance with the Geology and Soils section of Appendix G of the California Environmental Quality Act (CEQA) Environmental Checklist and professional judgment on anticipated impacts on existing geologic and soil resources. Under the National Environmental Policy Act (NEPA), effects must be evaluated in terms of their context and intensity. These factors have been considered when applying the State CEQA Guidelines in Appendix G. Impacts associated with Project implementation have been determined to be significant if they would do any of the following:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
  - Rupture of a known earthquake fault.
  - Strong seismic ground shaking.
  - Seismic-related ground failure, including liquefaction.
  - Landslides.
- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the 1994 Uniform Building Code, creating substantial risks to life or property.
- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State.
- 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.
- Cause changes in conditions resulting in destabilization of existing infrastructure, such as levees, dams, other structures.
- Cause a proposed structure to fail, exposing people, existing infrastructure, and environmental, economic or cultural resources to potential substantial adverse effects.

11.3.3 Impacts and Mitigation Measures

This section provides an evaluation of direct and indirect effects of the Project Alternatives on geologic and soils resources. The analysis considers the short-term construction phase as well as the long-term operational phase. Table 11-4 provides a summary of environmental concerns by resource type or hazard.

This section includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. The analysis is organized by Project alternative with specific impact topics numbered sequentially under each alternative.

With respect to geologic and soils resources, the environmental impact issues and concerns are:

1. Effects on Mineral and Soil Resources.
2. Soil Erosion Effects.
3. Adverse Soil Conditions.
4. Adverse Seismicity Effects.

Table 11-4.
Summary of Environmental Concerns

Resource or Hazard	Construction Phase (Short-Term Effects)	Operational Phase (Long-Term Effects)
Mineral resources	None	None
Soil resources	Potential effects	Potential long-term effects
Ground subsidence	None	Project designed for resource/hazard
Expansive soils	None	None
Corrosive soils	None	Project designed for resource/hazard
Collapsible soils	None	None
Difficult excavation	None	None
Soil erosion	Project designed for resource/hazard	Project designed for resource/hazard
Surface fault rupture	None	None
Seismic ground shaking	Unlikely during construction period	Project designed for resource/hazard
Liquefaction	Unlikely during construction period	Project designed for resource/hazard
Lateral spreading	Unlikely during construction period	Project designed for resource/hazard
Seismically induced flooding	Unlikely during construction period	Potential long-term effects
Landslide and rockfall	None	None
Subsurface gas	None	None

Note: Several hazards are unlikely to occur during the relatively short construction period. Nevertheless, they are included because they could theoretically be experienced during construction.

Other geologic and soils resource-related issues covered in the Program Environmental Impact Statement/Report (PEIS/R) are not covered here because they are programmatic in nature and/or are not relevant to the Project area.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. (See Section 2.2.3 for a detailed description of the No-Action Alternative.) However, other proposed actions under the SJRRP would be implemented, including habitat restoration, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, these Program-level activities would not achieve full Settlement goals. This section provides an analysis of the No-Action Alternative. The analysis is a comparison to existing conditions, and no mitigation is required for No-Action.

Impact GEO-1 (No-Action Alternative): ***Effects on Mineral and Soil Resources*****.** Under the No-Action Alternative, the Project would not be implemented and there would be no changes to existing geologic and soils conditions in the Project area as a result of construction activities or the placement of new Project facilities. As a result, there would be **no impact** on existing geologic and soils resources due to Project construction. (Potential impacts due to changes in erosion and deposition rates are discussed below.)

Impact GEO-2 (No-Action Alternative): ***Soil Erosion Effects*****.** Under the No-Action Alternative, the Project would not be implemented and there would be no new construction within Reach 2B. The No-Action Alternative would maintain the existing levee alignments and heights and maximum conveyance would continue to be limited to the existing capacity. As a result, there would be no erosion impacts related to or affecting new Reach 2B structures. However, compared to existing conditions (i.e., pre-Interim Flow conditions as of July 2009), the Program would implement changes to the management of discharges into the San Joaquin River from Friant Dam and these flows could affect sediment transport conditions within Reach 2B. Recent sediment continuity studies have predicted that sand inputs from Reach 2A under Restoration Flows would likely result in net deposition in the upper segment of Reach 2B and potentially down to the Mendota Pool. Net deposition also occurs in Reach 2B under existing conditions (SJRRP 2011, page 10-34).

Compared to existing conditions, soil erosion and deposition rates could change with implementation of Restoration Flows by the Program; however, maximum conveyance in Reach 2B would continue to be limited to the existing capacity and the reach would continue to experience net deposition. As a result, impacts to soil resources as a result of erosion and deposition within Reach 2B would be **less than significant**.

Impact GEO-3 (No-Action Alternative): *Adverse Soil Conditions*. Under the No-Action Alternative, the Project would not be implemented and there would be no new construction within Reach 2B. As a result, potentially corrosive soils or potential ground subsidence within Reach 2B would not impact Project structures. Compared to existing conditions, potential impacts to existing structures due to potentially corrosive soils or potential ground subsidence would remain unchanged and there would be no increase in risk that existing or proposed structures would fail as a result of adverse soil conditions. Therefore, there would be **no impact.**

Impact GEO-4 (No-Action Alternative): *Adverse Seismicity Effects*. Under the No-Action Alternative, the Project would not be implemented and there would be no new construction within Reach 2B. As a result, seismicity effects (e.g., seismic ground shaking, liquefaction, lateral spreading, and seismically induced flooding) would not impact Project structures. Compared to existing conditions, potential impacts to existing structures as a result of seismicity effects would remain unchanged. The likelihood of seismicity affecting the Project area would remain unchanged under this or any of the action alternatives and there would be no increase in risk that existing structures would fail as a result of these potential seismicity effects. Therefore, there would be **no impact**.

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities capable of conveying up to 4,500 cfs including a Compact Bypass channel, a new levee system encompassing the river channel with a narrow floodplain, and the South Canal. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure and fish passage facility, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure. (See Section 2.2.5 for a detailed description of the Alternative A.) No construction activities are proposed at or near Mendota Dam, which falls outside the Project boundary.

Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

Impact GEO-1 (Alternative A): *Effects on Mineral and Soil Resources*. Compared to the No-Action Alternative, Project construction for Alternative A would include the Compact Bypass, the South Canal, a 3,000-foot-wide floodplain, and levees along both sides of the floodplain. Currently soils within the footprints of these structures (i.e., the Compact Bypass, South Canal, and narrow floodplain levees) include about 1,410 acres that are farmed. Also, the approximately 3,000-foot-wide floodplain area between the two new levees would be unavailable for farming many current crops under Alternative A, but a portion of the floodplain would be available for annual crops, pasture, or floodplain-compatible permanent crops. Areas where there would be temporary construction impacts include construction office sites, equipment maintenance and parking areas, and material storage areas. It is estimated that approximately 62 acres would temporarily be impacted by this construction; most of these areas are currently in agricultural production. A more detailed discussion of impacts to farming is presented in Chapter 16, “Land Use Planning and Agricultural Resources.”

Borrow material would primarily be required for the construction of the levees, but it may also be used in the construction of other structures for foundation or backfill material. Levees may be constructed entirely of local borrow material, a mix of local and imported borrow material, or just imported borrow material. Borrow locations would be determined after a geotechnical exploration of potential local borrow areas is complete (see Section 2.2.4). It is estimated that up to 350 acres of land would be needed for borrow areas. Some of the soils excavated to construct the Compact Bypass and the South Canal might be used for levee construction, and if this is possible, then the size of the borrow areas may be reduced. Excavation of borrow materials would be done in accordance with Reclamation design standards permit requirements.

When comparing Alternative A to existing conditions, impacts to soil resources from construction activities would be similar to those described above (i.e., the comparison of Alternative A to the No-Action Alternative). Because borrow material would be excavated in accordance with Reclamation guidelines designed to be protective of soil resources, impacts to soil resources would be **less than significant**.

Impact GEO-2 (Alternative A): *Soil Erosion Effects*. Compared to the No-Action Alternative, short-term increases in erosion could occur during construction as a result of disturbed soils. However, Reclamation would prepare and implement a SWPPP that complies with applicable Federal NPDES regulations concerning construction activities. Implementation of erosion control best management practices (BMPs) consistent with the Project’s construction SWPPP would minimize soil erosion during construction.

Under Alternative A, the long-term flow conveyance capacity of Reach 2B would increase to 4,500 cfs and Reach 2B would receive increased flows that could lead to changes in sediment transport conditions within the new Compact Bypass, the floodplain, and the South Canal. However, standard erosion protection measures, such as revetment, and proper hydraulic engineering design would be implemented to minimize erosion near

Project structures and levees (see Section 2.2.4). Proper engineering design of the new Project features, such as larger culverts that can pass higher flows with reduced scour, would minimize potential increases in soil erosion in the Project area following construction.

When comparing Alternative A to existing conditions, impacts from soil erosion effects would be similar to those described above (i.e., the comparison of Alternative A to the No-Action Alternative). As a result, the impact on erosion would be **less than significant**.

Impact GEO-3 (Alternative A): *Adverse Soil Conditions*. Compared to the No-Action Alternative, the Project design under Alternative A would include new earth structures, such as the Compact Bypass, South Canal, and levees, as well as other smaller reinforced concrete structures such as the South Canal bifurcation structure, fish passage facility, and fish screen; grade control structures in the Compact Bypass; and a fish barrier below Mendota Dam in Reach 3. Adverse soil conditions could negatively affect the long-term stability of Project features.

Under-seepage, water that seeps laterally by travelling under a dam or levee section, can occur when structures are underlain by permeable native soils. This may cause instability in the structures built on these soils. Seepage control measures would be included, as part of the Project, in areas where under-seepage is likely to affect adjacent land uses. Seepage control measures could include slurry walls, interceptor drains, seepage wells, seepage berms, land acquisition (fee title or seepage easements), and other measures that can be implemented within the Project area (see Section 2.2.4).[5]

Other adverse soil conditions within Reach 2B could include soils corrosive to buried concrete and/or steel and soils susceptible to consolidation and the related settlement of overlying structures. Site specific geotechnical exploration, testing, and analysis prior to final design would allow for the characterization of the site soils and appropriate design of all proposed structures such that potentially corrosive soils or subsidence conditions should not impact Project facilities. All design work would be completed in general accordance with Reclamation design standards, applicable design codes, and commonly accepted industry standards (see Section 2.2.4).

When comparing Alternative A to existing conditions, impacts from adverse soil conditions would be similar to those described above (i.e., the comparison of Alternative A to the No-Action Alternative). As a result, impacts of potentially adverse soils within Reach 2B on Project structures would be **less than significant**.

[5] A slurry wall is a construction technique to reinforce areas of soft earth that are near open water or a high groundwater table with a mixture of soil, bentonite, and cement. Interceptor drains are buried perforated pipes which intercept groundwater and redirect it to a discharge point. Because the drains have lower resistance to flow, the groundwater table can be kept artificially low in areas near the pipe. Seepage wells are groundwater wells that are used to pump and draw down the water table where seepage is occurring. Seepage berms are berms placed on the landside of a levee to add additional weight and width to the levee to counteract seepage.

Impact GEO-4 (Alternative A): *Adverse Seismicity Effects*. Compared to the No-Action Alternative, potential impacts to existing structures as a result of seismicity effects would remain unchanged. However, Reach 2B would be modified under Alternative A with the construction of the Compact Bypass, levees on the north and south sides of the expanded floodplain, the South Canal, and several other structures. Each of these structures would be built according to Reclamation design standards, the Corps engineering design standards, or equivalent standards (see Section 2.2.4). As a result, the new structures would be designed as necessary to withstand seismic forces, and foundations would be designed to protect the structure from the deleterious effects of strong ground shaking, liquefaction, and lateral spreading. The potential for flooding related to seismically induced dam failure cannot be lessened through the design of Project facilities; however, the Project would not include development that would put additional people at risk or increase flood risk at occupied structures.

Compared to existing conditions, potential impacts to existing structures as a result of seismicity effects would remain unchanged. The likelihood of seismicity affecting the existing Reach 2B area would remain unchanged under this or any of the other alternatives. Proposed structures would be designed to withstand seismic forces and protect against the deleterious effects of liquefaction and lateral spreading. Therefore, there would be **no impact.**

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features capable of conveying up to 4,500 cfs including a Compact Bypass channel, a new levee system with a wide, consensus-based floodplain encompassing the river channel, the Mendota Pool Control Structure, and the Compact Bypass Control Structure with fish passage facility. Other key features include construction of a fish passage facility at the San Joaquin River control structure at the Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass Control Structure), and removal of the San Mateo Avenue crossing. (See Section 2.2.6 for a detailed description of the Alternative B.) No construction activities are proposed at or near Mendota Dam, which falls outside the Project boundary. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

Impact GEO-1 (Alternative B): *Effects on Mineral and Soil Resources*. Compared to the No-Action Alternative, Project construction for Alternative B would include the Compact Bypass and an approximately 4,200-foot-wide floodplain with levees along both sides of the floodplain. Currently soils within the footprints of these two areas (Compact Bypass and wide, consensus-based floodplain levees) include about 1,600 acres that are farmed. A portion of this area would include a mixture of active and passive riparian and floodplain habitat restoration and would no longer be available for farming. Other areas where there would be temporary construction impacts include construction office sites, equipment maintenance and parking areas, and materials storage areas. It is estimated that approximately 60 acres would temporarily be impacted by this construction; most of these areas are currently in agricultural production. A more detailed discussion of impacts to farming is presented in Chapter 16, "Land Use Planning and Agricultural Resources."

Borrow material would primarily be required for the construction of the levees, but it may also be used in the construction of other structures for foundation or backfill material. Levees may be constructed entirely of local borrow material, a mix of local and imported borrow material, or just imported borrow material. Borrow locations would be determined after a geotechnical exploration of potential local borrow areas is complete; the exploration would determine the suitability of local soils for use as borrow material (see Section 2.2.4). It is estimated that up to 350 acres of land would be needed for borrow areas. Some of the soils excavated to construct the Compact Bypass might be used for levee construction, and if this is possible, then the size of the borrow areas may be reduced. Excavation of borrow materials would be done in accordance Reclamation design standards and permit requirements.

When comparing Alternative B to existing conditions, impacts to soil resources from construction activities would be the same as those described above (i.e., the comparison of Alternative B to the No-Action Alternative). Because borrow material would be excavated in accordance with Reclamation guidelines designed to be protective of soil resources, impacts to soil resources would be **less than significant**.

Impact GEO-2 (Alternative B): *Soil Erosion Effects*. Compared to the No-Action Alternative, short-term increases in erosion could occur during construction as a result of disturbed soils. However, Reclamation would prepare and implement a SWPPP that complies with applicable Federal NPDES regulations concerning construction activities. Implementation of erosion control BMPs consistent with the Project's construction SWPPP would minimize soil erosion during construction.

Under Alternative B, the long-term flow conveyance capacity of Reach 2B would increase to 4,500 cfs and Reach 2B would receive increased flows that could lead to changes in sediment transport conditions within the new Compact Bypass, the floodplain, and adjacent to new structures. However, standard erosion protection measures such as revetment and proper hydraulic engineering design would be implemented to minimize erosion near Project structures and levees (see Section 2.2.4). Proper engineering design of the new Project features would minimize potential increases in soil erosion in the Project area following construction.

When comparing Alternative B to existing conditions, impacts from soil erosion effects would be similar to those described above (i.e., the comparison of Alternative B to the No-Action Alternative). As a result, the impact on erosion would be **less than significant** due to construction of Alternative B.

Impact GEO-3 (Alternative B): *Adverse Soil Conditions*. Compared to the No-Action Alternative, the Project under Alternative B would include new earth structures such as the Compact Bypass and levees, as well as other reinforced concrete structures such as the Mendota Pool Control Structure, the Compact Bypass Control Structure, fish passage facility, and grade control structures in the Compact Bypass. Adverse soil conditions could negatively affect the long-term stability of Project features.

Under-seepage, water that seeps laterally by travelling under a dam or levee section, can occur when structures are underlain by permeable native soils. This may cause instability in the structures built on these soils. Seepage control measures (as described above for Impact GEO-3 [Alternative A]) would be included, as part of the Project, in areas where under-seepage is likely to affect adjacent land uses (see Section 2.2.4).

Other adverse soil conditions within Reach 2B could include soils corrosive to buried concrete and/or steel and soils susceptible to consolidation and the related settlement of overlying structures. Site-specific geotechnical exploration, testing, and analysis prior to final design would allow for the characterization of the site soils and appropriate design of all proposed structures such that potentially corrosive soils or subsidence conditions should not impact Project facilities. All design work would be completed in general accordance with Reclamation Design Standards, applicable design codes, and commonly accepted industry standards (see Section 2.2.4).

When comparing Alternative B to existing conditions, impacts from adverse soil conditions would be similar to those described above (i.e., the comparison of Alternative B to the No-Action Alternative). As a result, impacts of potentially adverse soils within Reach 2B on Project structures would be **less than significant**.

Impact GEO-4 (Alternative B): ***Adverse Seismicity Effects.*** Compared to the No-Action Alternative, potential impacts to existing structures as a result of seismicity effects would remain unchanged. However, Reach 2B would be modified under Alternative B with new construction of the Compact Bypass and bypass control structures, levees on the north and south sides of the expanded floodplain, and other structures. Each of these structures would be built according to Reclamation design standards, the Corps engineering design standards, or equivalent standards (see Section 2.2.4). As a result, the new structures would be designed as necessary to withstand seismic forces, and foundations would be designed to protect the structure from the deleterious effects of liquefaction and lateral spreading. The potential for flooding related to seismically induced dam failure cannot be lessened through the design of Project facilities; however, the Project would not include development that would put additional people at risk or increase flood risk at occupied structures.

Compared to existing conditions, potential impacts to existing structures as a result of seismicity effects would remain unchanged. The likelihood of seismicity affecting the existing Reach 2B area would remain unchanged under this or any of the other alternatives. Proposed structures would be designed to withstand seismic forces and protect against the deleterious effects of liquefaction and lateral spreading. Therefore, there would be **no impact.**

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a new levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. (See Section 2.2.7 for a detailed description of the Alternative C.) Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Impact GEO-1 (Alternative C): *Effects on Mineral and Soil Resources*. Compared to No-Action, Project construction for Alternative C would include the new Fresno Slough Dam, adjacent Short Canal, floodplain, and levees along both sides of the floodplain. The Fresno Slough Dam would be constructed in an area that is not farmed. Currently soils within the footprint of the new levees and South Canal include about 1,170 acres that are farmed. These areas would no longer be available for farming. The approximately 3,000-foot-wide area between the two new floodplain levees would be revegetated as part of the habitat restoration program and would not be available for farming under Alternative C. Other areas where there would be temporary construction impacts include construction office sites, equipment maintenance and parking areas, and materials storage areas. It is estimated that approximately 62 acres would temporarily be impacted by this construction; most of these areas are currently in agricultural production. A more detailed discussion of impacts to farming is presented in Chapter 16, “Land Use Planning and Agricultural Resources.”

Borrow material would primarily be required for the construction of the levees, but it may also be utilized in the construction of other structures for foundation or backfill material. Levees may be constructed entirely of local borrow material, a mix of local and imported borrow material, or just imported borrow material. Borrow locations would be determined after a geotechnical exploration of potential local borrow areas is complete; the exploration would determine the suitability of local soils for use as borrow material (see Section 2.2.4). It is estimated that up to 350 acres of land would be needed for borrow areas. Some of the soils excavated to construct the Short Canal might be used for levee construction, and if this is possible, then the size of the borrow areas may be reduced. Excavation of borrow materials would be done in accordance with Reclamation design standards and permit requirements.

When comparing Alternative C to existing conditions, impacts to soil resources from construction activities would be the same as those described above (i.e., the comparison of Alternative C to the No-Action Alternative). Because borrow material would be excavated in accordance with Reclamation guidelines designed to be protective of soil resources, impacts to soil resources would be **less than significant**.

Impact GEO-2 (Alternative C): *Soil Erosion Effects*. Compared to the No-Action Alternative, short-term increases in erosion could occur during construction as a result of disturbed soils. However, Reclamation would prepare and implement a SWPPP that complies with applicable Federal NPDES regulations concerning construction activities. Implementation of erosion control BMPs consistent with the Project’s construction SWPPP would minimize soil erosion during construction.

Under Alternative C, the long-term flow conveyance capacity of Reach 2B would increase to 4,500 cfs and Reach 2B would receive increased flows that could lead to changes in sediment transport conditions within the floodplain and adjacent to structures. However, standard erosion protection measures such as revetment and proper hydraulic engineering design would be implemented to minimize erosion near Project structures and levees (see Section 2.2.4). Proper engineering design of the new Project features would minimize potential increases in soil erosion in the Project area following construction.

When comparing Alternative C to existing conditions, impacts from soil erosion effects would be similar to those described above (i.e., the comparison of Alternative C to the No-Action Alternative). As a result, the impact on erosion would be **less than significant** due to construction of Alternative C.

Impact GEO-3 (Alternative C): *Adverse Soil Conditions*. Compared to the No-Action Alternative, the Project design under Alternative C would include new earth structures such as the floodplain and levees, as well as reinforced concrete structures such as the Fresno Slough Dam, fish passage facilities at Mendota Dam and Chowchilla Bypass, grade control structures downstream of Mendota Dam, Short Canal, and improved San Mateo Avenue crossing. Adverse soil conditions could negatively affect the long-term stability of Project features.

Under-seepage, water that seeps laterally by travelling under a dam or levee section, can occur when structures are underlain by permeable native soils. This may cause instability in the structures built on these soils. Seepage control measures (as described above for Impact GEO-3 [Alternative A]) would be included, as part of the Project, in areas where under-seepage is likely to affect adjacent land uses (see Section 2.2.4).

Other adverse soil conditions within Reach 2B could include soils corrosive to buried concrete and/or steel and soils susceptible to consolidation and the resultant settlement of overlying structures. Site specific geotechnical exploration, testing, and analysis prior to final design would allow for the characterization of the site soils and appropriate design of all proposed structures such that potentially corrosive soils or subsidence conditions should not impact Project facilities. All design work would be completed in general accordance with Reclamation Design Standards, applicable design codes, and commonly accepted industry standards (see Section 2.2.4).

When comparing Alternative C to existing conditions, impacts from adverse soil conditions would be similar to those described above (i.e., the comparison of Alternative C to the No-Action Alternative). As a result, impacts of potentially adverse soils within Reach 2B on Project structures would be **less than significant**.

Impact GEO-4 (Alternative C): *Adverse Seismicity Effects*. Compared to the No-Action Alternative, potential impacts to existing structures as a result of seismicity effects would remain unchanged. However, Reach 2B would be modified under Alternative C with construction of the Fresno Slough Dam, adjacent Short Canal, and floodplain and levees along both sides of the river, as well as several other structures. Each of these structures would be built according to Reclamation design standards, the Corps engineering design standards, or equivalent standards (see Section 2.2.4). As a result, the new structures would be designed as necessary to withstand seismic forces, and foundations would be designed to protect the structure from the deleterious effects of liquefaction and lateral spreading. The potential for flooding related to seismically induced dam failure cannot be lessened through the design of Project facilities; however, the Project would not include development that would put additional people at risk or increase flood risk at occupied structures.

Compared to existing conditions, potential impacts to existing structures as a result of seismicity effects would remain unchanged. The likelihood of seismicity affecting the existing Reach 2B area would remain unchanged under this or any of the other alternatives. Proposed structures would be designed to withstand seismic forces and protect against the deleterious effects of liquefaction and lateral spreading. Therefore, there would be **no impact.**

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a new levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough Dam fish barrier, the North Canal bifurcation structure, fish passage facility, and fish screen, removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. (See Section 2.2.8 for a detailed description of the Alternative D.) Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Impact GEO-1 (Alternative D): *Effects on Mineral and Soil Resources*. Compared to No-Action, Project construction for Alternative D would include the Fresno Slough Dam, floodplain and levees along both sides of the river and the North Canal. The Fresno Slough Dam would be constructed in an area that is not farmed. Currently soils within the footprint of the new levees and North Canal include about 1,900 acres that are farmed. Also, the approximately 4,200-foot-wide floodplain would be unavailable for farming many current crops under Alternative D, but a portion of the floodplain would be available for annual crops, pasture, or floodplain-compatible permanent crops. Other areas where there would be temporary construction impacts include construction office sites, equipment maintenance and parking areas, and materials storage areas. It is estimated that approximately 62 acres would temporarily be impacted by this construction; most of these areas are currently in agricultural production. A more detailed discussion of impacts to farming are presented in Chapter 16, "Land Use Planning and Agricultural Resources."

Borrow material would primarily be required for the construction of the levees, but it may also be utilized in the construction of other structures for foundation or backfill material. Levees may be constructed entirely of local borrow material, a mix of local and imported borrow material, or just imported borrow material. Borrow locations would be determined after a geotechnical exploration of potential local borrow areas is complete;

the exploration would determine the suitability of local soils for use as borrow material (see Section 2.2.4). It is estimated that up to 350 acres of land would be needed for borrow areas. Some of the soils excavated to construct the North Canal might be used for levee construction, and if this is possible, then the size of the borrow areas may be reduced. Excavation of borrow materials would be done in accordance with Reclamation design standards and permit requirements.

When comparing Alternative D to existing conditions, impacts to soil resources from construction activities would be similar to those described above (i.e., the comparison of Alternative D to the No-Action Alternative). Because borrow material would be excavated in accordance with Reclamation guidelines designed to be protective of soil resources, impacts to soil resources would be **less than significant**.

Impact GEO-2 (Alternative D): *Soil Erosion Effects*. Compared to the No-Action Alternative, short-term increases in erosion could occur during construction as a result of disturbed soils. However, Reclamation would prepare and implement a SWPPP that complies with applicable Federal NPDES regulations concerning construction activities. Implementation of erosion control BMPs consistent with the Project's construction SWPPP would minimize soil erosion during construction.

Under Alternative D, the long-term flow conveyance capacity of Reach 2B would increase to 4,500 cfs and Reach 2B would receive increased flows that could lead to changes in sediment transport conditions within the expanded floodplain and adjacent to new structures. However, standard erosion protection measures such as revetment and proper hydraulic engineering design would be implemented to minimize erosion near Project structures and levees (see Section 2.2.4). Proper engineering design of the new Project features would minimize potential increases in soil erosion in the Project area following construction.

When comparing Alternative D to existing conditions, impacts from soil erosion effects would be similar to those described above (i.e., the comparison of Alternative D to the No-Action Alternative). As a result, the impact on erosion would be **less than significant** due to construction of Alternative D.

Impact GEO-3 (Alternative D): *Adverse Soil Conditions*. Compared to the No-Action Alternative, the Project design under Alternative D would include new earth structures such as the floodplain, levees, and North Canal, as well as reinforced concrete structures such as the Fresno Slough Dam, fish passage facilities at Mendota Dam, grade control structures downstream of Mendota Dam, and North Canal bifurcation structure, fish passage facility, and fish screen. Adverse soil conditions could negatively affect the long-term stability of Project features.

Under-seepage, water that seeps laterally by travelling under a dam or levee section, can occur when structures are underlain by permeable native soils. This may cause instability in the structures built on these soils. Seepage control measures (as described above for Impact GEO-3 [Alternative A]) would be included, as part of the Project, in areas where under-seepage is likely to affect adjacent land uses (see Section 2.2.4).

Other adverse soil conditions within Reach 2B could include soils corrosive to buried concrete and/or steel and soils susceptible to consolidation and the resultant settlement of overlying structures. Site specific geotechnical exploration, testing, and analysis prior to final design would allow for the characterization of the site soils and appropriate design of all proposed structures such that potentially corrosive soils or subsidence conditions should not impact Project facilities. All design work would be completed in general accordance with Reclamation Design Standards, applicable design codes, and commonly accepted industry standards (see Section 2.2.4).

When comparing Alternative D to existing conditions, impacts from adverse soil conditions would be similar to those described above (i.e., the comparison of Alternative D to the No-Action Alternative). As a result, impacts of potentially adverse soils within Reach 2B on Project structures would be **less than significant**.

Impact GEO-4 (Alternative D): *Adverse Seismicity Effects*. Compared to the No-Action Alternative, potential impacts to existing structures as a result of seismicity effects would remain unchanged. However, Reach 2B would be modified under Alternative D with the construction of the Fresno Slough Dam, floodplain and levees along both sides of the river, and North Canal, and as well as several other structures. Each of these structures would be built according to Reclamation design standards, the Corps engineering design standards, or equivalent standards (see Section 2.2.4). As a result, the new structures would be designed as necessary to withstand seismic forces, and foundations would be designed to protect the structure from the deleterious effects of liquefaction and lateral spreading. The potential for flooding related to seismically induced dam failure cannot be lessened through the design of Project facilities; however, the Project would not include development that would put additional people at risk or increase flood risk at occupied structures.

Compared to existing conditions, potential impacts to existing structures as a result of seismicity effects would remain unchanged. The likelihood of seismicity affecting the existing Reach 2B area would remain unchanged under this or any of the other alternatives. Proposed structures would be designed to withstand seismic forces and protect against the deleterious effects of liquefaction and lateral spreading. Therefore, there would be **no impact.**

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12.0 Hydrology - Flood Management

This chapter describes the environmental and regulatory settings for flood management and environmental consequences and mitigation, which could potentially be affected by implementation of Project alternatives.

12.1 Environmental Setting

The environmental setting for flood management includes a discussion of flood protection history in the San Joaquin River basin, flood management structures, and flood management operations and conditions. Much of the information presented in this section was obtained from the Upper San Joaquin River Basin Storage Investigation Initial Alternatives Report Information Report, Flood Damage Reduction Technical Appendix (U.S. Department of the Interior, Bureau of Reclamation [Reclamation] and California Department of Water Resources [DWR] 2005) and is summarized below.

12.1.1 Historical Perspective of Flood Protection in the San Joaquin River Basin

Historically, the San Joaquin River had insufficient capacity to carry heavy winter and spring flows generated by precipitation and/or snowmelt within its channel banks. Once flows exceeded channel capacities, the channels overflowed onto the surrounding countryside, forming vast floodplains. Velocities in overbank areas were greatly reduced from velocities in the channels reducing the sediment-carrying capacity of the water allowing material naturally eroded from mountain and foothill areas to drop out of suspension. In this way, over many years, the San Joaquin River built up its bed and formed natural levees composed of heavier, coarser material carried by flood flows. Finer material stayed in suspension much longer and dropped out when overflow water ponded in basins that developed east and west of the river. The higher elevation land formed by the natural levees attracted the first settlements in the Central Valley. In the early 1800s, settlers and Native Americans described the Sacramento and San Joaquin rivers as “miles wide” during flooding.

Early Flood Protection

Initial flood protection in the Central Valley developed in a piecemeal fashion with the construction of levees to protect local areas from flooding. Levees were typically constructed in response to a past flood, with little or no coordination between different localities. As the private levee system developed, the protection afforded by individual levees decreased because of the increased heights of floodwaters constrained between the levees. The increased flood danger led to competition between landowners to continually raise and strengthen levees by stages to protect local areas and direct floodwaters elsewhere.

By the early 1900s, it was evident that local efforts would not be adequate to provide flood protection to agricultural lands in the Sacramento River and San Joaquin River basins. In 1920, Colonel Robert Marshall, chief geographer for the U.S. Geological Survey (USGS), proposed a major water storage and conveyance plan to transfer water from Northern California to meet urban and agricultural needs of central and Southern California. This plan ultimately provided the framework for development of the Central Valley Project (CVP). Under the Marshall Plan, a dam would be constructed on the San Joaquin River near Friant to divert water north and south to areas in the eastern portion of the San Joaquin Valley, and provide flood protection to downstream areas. The diverted water would be a supplemental supply to relieve some of the dependency on groundwater that had led to overdraft in areas of the eastern San Joaquin Valley. Water in the Sacramento Valley would be collected, stored, and transferred to the San Joaquin Valley by a series of reservoirs, pumps, and canals.

In 1933, the California State Legislature approved the Central Valley Project Act, which authorized construction of initial features of the CVP, including Shasta Dam; Friant Dam; power transmission facilities from Shasta to Tracy; and the Contra Costa, Delta-Mendota, Madera, and Friant-Kern canals. However, the Great Depression prevented the State from financing the project so the State appealed to the Federal Government for assistance in constructing the CVP.

Congress appropriated funds and authorized construction of the CVP and construction began on October 19, 1937, with the Contra Costa Canal. Construction of Shasta Dam began in 1938 and was completed for full operation in 1949. Friant Dam, on the San Joaquin River, was also completed in 1949.

The Flood Control Act of 1944 authorized the Lower San Joaquin River and Tributaries Project. The project included constructing levees on the San Joaquin River below the Merced River, Stanislaus River, Old River, Paradise Cut, and Camp Slough. Construction was initiated on the Lower San Joaquin River and Tributaries Project in 1956.

The Chowchilla and Eastside bypasses were constructed by the State as part of the Lower San Joaquin River Flood Control Project (Flood Control Project).

12.1.2 Flood Management Structures

Friant Dam

Friant Dam is the principal flood damage reduction facility on the San Joaquin River and is operated to maintain combined releases to the San Joaquin River at or below a flow objective of 8,000 cubic feet per second (cfs). Several flood events, as described below, in the past few decades have resulted in flows greater than 8,000 cfs downstream from Friant Dam and, in some cases, flood damages resulted.

The existing Friant Dam is a 319-foot-tall concrete gravity dam with a crest length of 3,488 feet and a crest width of 20 feet. Millerton Lake, formed by Friant Dam, has a volume of 520,500 acre-feet. The dam serves the dual purposes of storage for irrigation and flood management. The minimum operating storage of Millerton Lake is 130 thousand acre-feet (TAF), resulting in active available conservation storage of about 390 TAF. The minimum operating storage allows for diversion from dam outlets to the Friant-Kern Canal, Madera Canal and the San Joaquin River. During the rainy season of October through March up to 170 TAF of available storage space must be maintained for management of rain floods.

San Joaquin River

Except for a small area to the west and south of Fresno Slough, the Project area is located in a Federal Emergency Management Agency (FEMA) Special Flood Hazard Zone A (no base flood elevations have been determined). The area adjacent to Fresno Slough is designated as Zone AO (1 to 3 feet of flood depth).

Chowchilla Bypass and Chowchilla Bifurcation Structure

The flood control structure most relevant to Reach 2B is the Chowchilla Bypass and Chowchilla Bifurcation Structure, owned by DWR and the Central Valley Flood Protection Board (CVFPB) for the State of California.[1] The Chowchilla Bypass begins at the Chowchilla Bifurcation Structure in the San Joaquin River and runs northwest, parallel to the San Joaquin River, to the confluence of the Fresno River, where the Chowchilla Bypass ends and essentially becomes the Eastside Bypass. The design channel capacity of the Chowchilla Bypass is 5,500 cfs. The bypass is constructed in highly permeable soils, and much of the initial flood flows infiltrate and recharge groundwater. The Chowchilla Bifurcation Structure is a gated structure that controls the proportion of flood flows between the Chowchilla Bypass and the San Joaquin River Reach 2B. The bifurcation structure has a drop (plunge pool) on the downstream side in both the San Joaquin River and Chowchilla Bypass, and has no fish passage facilities. The Chowchilla Bifurcation Structure is operated to keep flows in Reach 2B at a level less than 2,500 cfs because of channel design capacity limitations. Therefore, operating rules for the Chowchilla Bifurcation Structure are based on initial flow to the San Joaquin River and initial flow to the Chowchilla Bypass (McBain and Trush 2002). The intended design capacities for the various sections of the San Joaquin River reaches in the Project area are described in Table 12-1.

Mendota Dam

Mendota Dam is located at the confluence of the San Joaquin River and Fresno Slough. Mendota Pool is a small reservoir, with approximately 8,000 acre-feet of storage, created by Mendota Dam. The Mendota Pool does not provide any appreciable flood storage. The water surface elevation in the Pool is maintained by a set of gates and flashboards that are manually opened/removed in advance of high-flow conditions. This process lowers the water level in the pool for passing high flows to reduce seepage impacts to adjacent lands, but hinders distribution of flows into the canals.

Over time, the Mendota Pool has partially filled with sediment during infrequent high-flow releases from Friant Dam. During times of high flows, some unknown portion

[1] This document uses the term “Chowchilla Bifurcation Structure” to collectively refer to the San Joaquin River control structure, which spans the San Joaquin River, and the Chowchilla Bypass control structure (also known as the Chowchilla Canal Bypass Control Structure), located at the head of the Chowchilla Bypass.

of this sediment is able to flush and route downstream when flashboards have been removed, restoring much of the Mendota Pool storage capacity. If the flashboards are not removed before a high-flow event from either the San Joaquin River or Kings River via Fresno Slough, the increased water surface elevations cause seepage problems on upstream and adjacent properties.

Table 12-1.
Design Capacities of San Joaquin River and Chowchilla Bypass Within the Project Area and Vicinity

Reach	Upstream Extent	Downstream Extent	Levee Type[a]	Design Capacity (cfs)[b]
Reach 2A	Gravelly Ford	Chowchilla Bifurcation Structure	Project	8,000
Reach 2B	Chowchilla Bifurcation Structure	Mendota Dam	Non-project	2,500
Reach 3	Mendota Dam	Sack Dam	Non-project	4,500
Reach 4A	Sack Dam	Sand Slough Control Structure	Non-project	4,500
Kings River North	Fresno Slough Bypass	Mendota Pool	Non-project	4,750
Chowchilla Bypass	Chowchilla Bifurcation Structure	Confluence with Fresno River and Eastside Bypass	Project	5,500
Eastside Bypass	Fresno River	Sand Slough Bypass	Project	10,000-17,500
Sand Slough Bypass	Sand Slough Control Structure	Eastside Bypass	Project	3,000

Notes:
[a] Project levees are those levees constructed to Federal standards as part of a Federal flood control project, in this case, the Lower San Joaquin River Flood Control Project, and non-project levees are those constructed by individual landowners to protect site-specific properties.
[b] Design capacity is defined by the U.S. Army Corps of Engineers (Corps) as the amount of water that can pass through reaches of the San Joaquin River with a levee freeboard of 3 feet and Chowchilla Bypass with a levee freeboard of 4 feet.
Key:
cfs = cubic feet per second

Fresno Slough and the Kings River

Fresno Slough connects the Kings River to the San Joaquin River through the James Bypass. The James Bypass is a leveed channel beginning in the lower Kings River basin and runs northwest to Fresno Slough. The Fresno Slough delivers water to the south from Mendota Pool during irrigation season, and delivers water to the Mendota Pool and San Joaquin River from the Kings River when the Kings River is flooding. Due to this flood inflow, Kings River system operations influence operations on the San Joaquin River at Chowchilla Bifurcation Structure, Mendota Pool, and downstream.

Levees

There are two classes of levees and dikes along the San Joaquin River near Reach 2B: (1) those associated with the Flood Control Project (project levees), and (2) those constructed by individual landowners to protect site-specific properties, and thus not associated with the Flood Control Project (non-project levees). There are only non-project levees in Reach 2B; however, project levees exist along the lower portion of Reach 2A and along the entire length of the Chowchilla Bypass.

The Flood Control Project consists of a parallel conveyance system: (1) a leveed bypass system on the east side of the San Joaquin Valley, and (2) a leveed flow conveyance system in the San Joaquin River. The mainstem San Joaquin River levee system is composed of approximately 192 miles of project levees and various non-project levees located upstream from the Merced River confluence. Project levees are levees constructed as part of the Flood Control Project by the State, and occur in Reach 2A downstream from Gravelly Ford and extend downstream to the Chowchilla Bifurcation Structure. There are no project levees in Reach 2B. Information on dimensions of estimated channel capacities for locally constructed levees is difficult to obtain and, in some cases, is currently unavailable.

Figure 12-1 shows the levee flood protection zones for the San Joaquin River. Under California Water Code section 9110, subdivision (b), "Levee Flood Protection Zone" means the area, as determined by the CVFPB or DWR that is protected by a project levee. DWR delineated the levee flood protection zones by estimating the maximum area that may be flooded and where flood levels could exceed 3 feet deep if a project levee fails with flows at maximum capacity that may reasonably be conveyed. Reach 2B is not protected by project levees. However, the levee flood protection zone map shown in Figure 12-1 indicates that the entire Project area is subject to inundation with some areas subject to flooding greater than 3 feet if a levee was to fail.

12.1.3 Flood Management Operations and Conditions

The following sections contain information about flood management operations in the Project area and vicinity.

San Joaquin River

The 8,000 cfs objective flow from Friant Dam is generally considered to be a safe carrying capacity, though some flood damages to adjacent land developments can occur when objective flows are passed. These damages can occur because of levee under-seepage and through-seepage, and backwater effects on local storm drainage systems. Design capacity is defined by the U.S. Army Corps of Engineers (Corps) as the amount of water that can pass through reaches of the San Joaquin River with a levee freeboard of 3 feet. In many reaches of the San Joaquin River, the effective flood capacity of the channel has decreased over time. For example, the intended design capacity of Reach 2B is 2,500 cfs with 3-foot freeboard. The current recommended capacity at Reach 2B for conveyance of Restoration Flows is 1,120 cfs, based on the ground elevations near the landside levee toe (San Joaquin River Restoration Program [SJRRP] 2016).

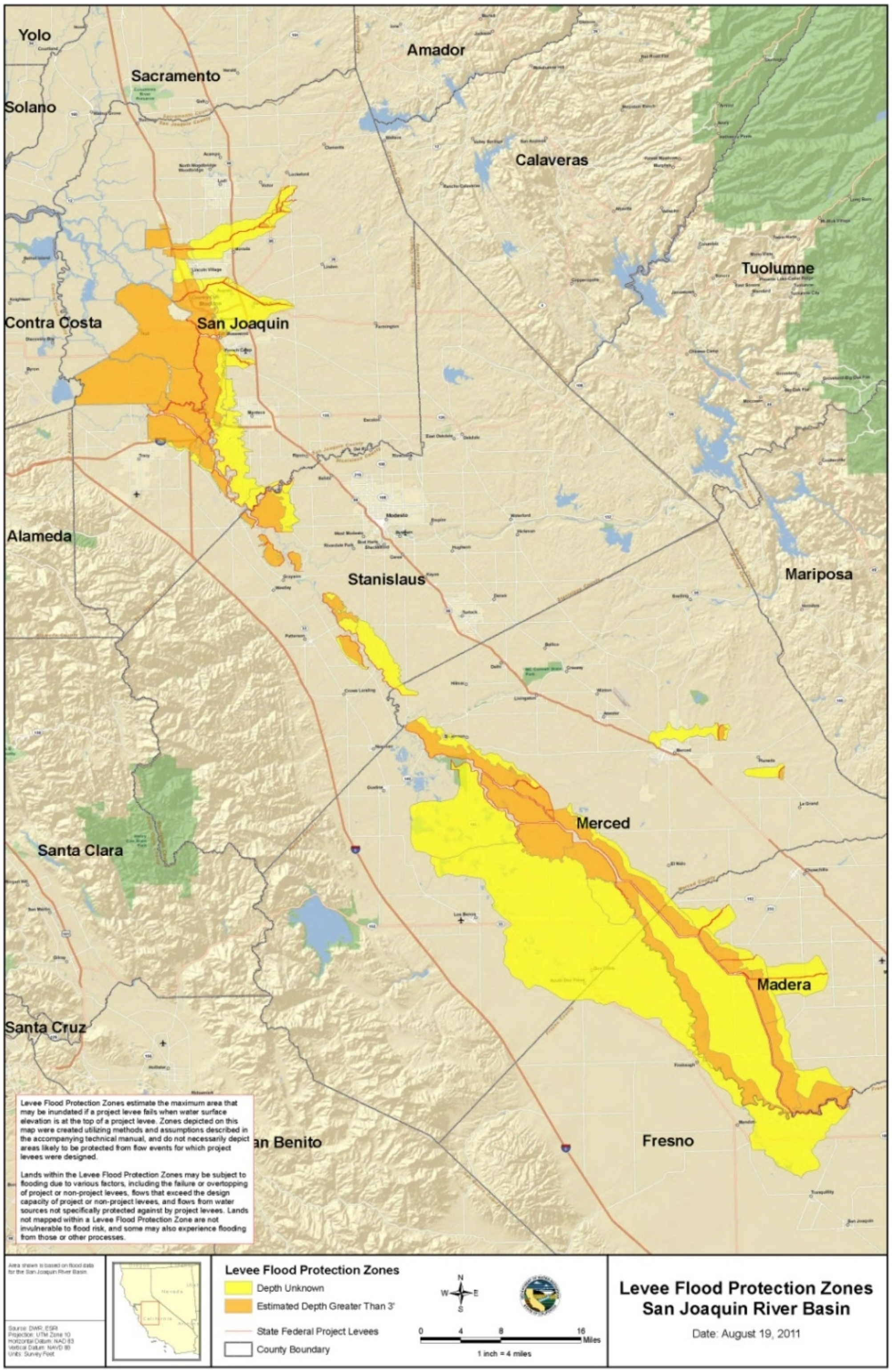


Figure 12-1.
Levee Flood Protection Zones in the San Joaquin River Basin

In all cases, water from the Kings River system has priority to use available capacity in the San Joaquin River below the Mendota Pool. When flood flows are below channel capacities, the Lower San Joaquin Levee District (LSJLD) has the latitude to best use the design capacities of the Flood Control Project.

The following operation and maintenance guidelines describe how the system is operated (Reclamation Board 1969).

- The first increment of flow down the San Joaquin River may be routed through either the San Joaquin River or the Chowchilla Bypass. Up to 2,500 cfs would normally be routed through the San Joaquin River insofar as it does not exceed the capacity of the river when added to the releases from the Kings River. Up to 5,500 cfs would be passed through the Chowchilla Bypass Bifucation Structure. A total flow of 8,000 cfs would normally be divided with 2,500 cfs passing to the river and 5,500 cfs passing to the Chowchilla Bypass.
- Should the flows exceed 8,000 cfs at the control structures or 10,000 cfs at the latitude of Mendota (i.e., the total flow in the San Joaquin River, via Reach 2 and James Bypass/Fresno Slough, and the Chowchilla Bypass at the latitude of Mendota), the LSJLD would operate the control structures at their own discretion with the objective of minimizing damage to the flood control project and protected area.

Major Recent Floods

The following flood event descriptions as reported in Reclamation and DWR (2005) are drawn from the Corps report (Corps 1999). Between 1900 and 1997, the Sacramento River and San Joaquin River basins experienced 13 destructive floods each located in a different portion of the Central Valley. The most recent floods (1983, 1986, 1995, and 1997) caused extensive damage in both the Sacramento River and San Joaquin River basins and raised questions about the adequacy of the current flood management systems and land use in the floodplains. In response to these floods, Congress authorized the Corps in 1997 to undertake a comprehensive study of the flood damage reduction facilities in the Sacramento River and San Joaquin River basins, and to prepare a summary of recent flood events.

Flood of 1955. The flood of 1955 occurred in December, was centered north of Friant Dam, and was more intense in the northern portions of the San Joaquin Valley and in the Sacramento Valley. Before the start of the flood, Millerton Lake was well below flood management space and, as a result, flows on the San Joaquin River were completely controlled by Friant Dam. The peak flow release from Friant Dam for this storm occurred on January 5, 1956, at 7,120 cfs. The flow stayed high for about 6 weeks.

Flood of 1967. Above-normal precipitation that occurred continuously from December 1966 through March 1967 resulted in the flooding of 35,000 acres of the San Joaquin River basin. A record-breaking storm in early December 1966 resulted in very high runoff from the San Joaquin River. The San Joaquin River above Millerton Lake experienced high runoff during early December with a maximum mean daily inflow of 18,450 cfs to the lake. The release from Millerton during this event was about 5,000 cfs and lasted about 1 week. A vast snowmelt from April to July resulted in significant flood damage from flooding in the lower portions of the Fresno and Chowchilla rivers. Nearly all of the flooded areas were cropland, improved pasture, or grazing land. Releases from Millerton climbed to about 8,000 cfs in the first week of April and remained there until the beginning of June. Flow did not return to normal until mid-July.

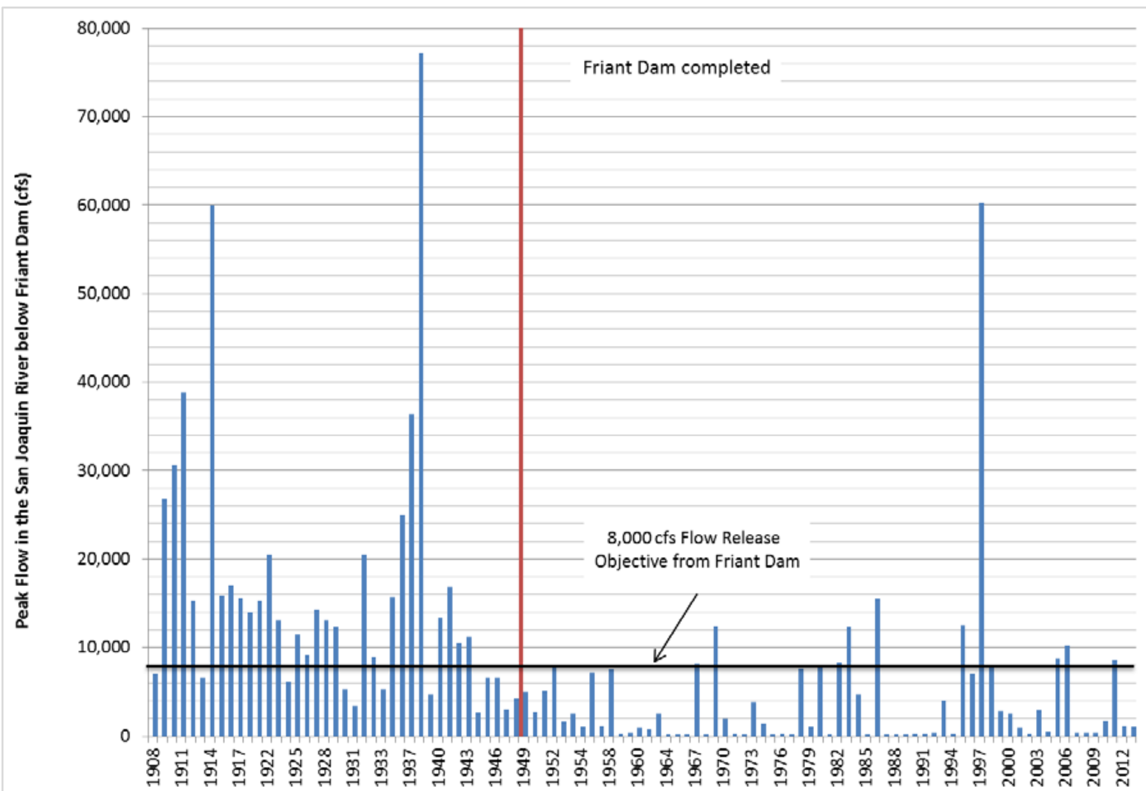
Flood of 1983. Water year 1983 was one of the wettest on record in California, a result of El Niño weather conditions. Northern and Central California experienced moderate flooding incidents from November through March because of numerous storms. In early May, snow water content in the Sierra Nevada exceeded 230 percent of normal, and the ensuing runoff resulted in approximately four times the average volume for Central Valley streams. In the San Joaquin River basin, levee breaks caused flooding at four locations along the San Joaquin River. Estimated damages exceeded $324 million in the San Joaquin River basin (Corps 1999). Releases from Millerton started to increase in the beginning of November reaching over 12,000 cfs in July, after which they returned to more normal conditions.

Flood of 1986. Flooding in 1986 resulted from a series of four storms over a 9-day period during February. Rains from the first three storms saturated the ground and produced moderate to heavy runoff before the arrival of the fourth storm. Peak daily inflow to Millerton Lake was about 20,800 cfs. Estimated damages exceeded $15 million in the San Joaquin River basin (Corps 1999). The peak flow from Millerton was 15,500 cfs on February 18. Flows started to return to normal in about mid-April.

Flood of 1995. El Niño conditions in the Pacific forced major storm systems directly into California during much of the winter and early spring of 1995. The largest storm systems hit California in early January and early March. The major brunt of the January storms hit the Sacramento River basin and resulted in small stream flooding primarily because of storm drainage system failures. The March 1995 storms were concentrated on the coastal range, and caused high flows in some of the west side tributaries to the San Joaquin River basin. Peak daily inflow to Millerton Lake was about 23,700 cfs. In total, estimated flood damages in 1995 exceeded $193 million in the San Joaquin River basin (Corps 1999). The peak release from Millerton was 12,500 cfs on March 11, but releases were high from the first week in March to almost August.

Flood of 1997. December 1996 was one of the wettest Decembers on record in the Central Valley. Watersheds in the Sierra Nevada already were saturated by the time three subtropical storms added more than 30 inches of rain in late December 1996 and early January 1997. The third and most severe of these storms lasted from December 31, 1996, through January 2, 1997. Rain in the Sierra Nevada caused record flows that overwhelmed the flood management system in the San Joaquin River basin. Peak daily inflow to Millerton Lake was about 51,800 cfs, with a peak hourly inflow of about 95,000 cfs. Peak daily outflows to the San Joaquin River from Friant Dam were estimated at 37,500 cfs, with a peak hourly outflow of 62,900 cfs. Dozens of levees failed throughout the river system and widespread flooding ensued. Estimated damages exceeded $223 million in the San Joaquin River basin (Corps 1999).

Since 1997 there have been four large flow releases from Friant Dam. In the beginning of June 1998, the flow increased to about 8,000 cfs and remained there for about 3 weeks then slowly decreased to normal levels. In mid-May 2005, the releases from Friant Dam increased to almost 9,000 cfs and remained there for about 2 weeks before dropping to more normal levels. In the beginning of April 2006, the releases increased to 10,000 cfs and remained high for several months decreasing to normal levels in July. In the beginning of April 2011, the releases increased over 8,000 cfs and remained high for several weeks. Releases peaked again in the end of June and the beginning of July 2011, reaching up to 8,500 cfs. Figure 12-2 shows the peak annual flows below Friant Dam (or at that location before Friant Dam was constructed). Since the dam was constructed in 1949 there have been only 12 events with releases from Friant Dam that exceeded the maximum flow objective of 8,000 cfs. Some of these events lasted many days or months.



Dates before construction of the Dam were collected in the river at the same location.

Figure 12-2.
Peak Annual Flows in the San Joaquin River below Friant Dam

12.1.4 Flood Management Agencies

Federal Emergency Management Agency

Congress established the National Flood Insurance Program to address both the need for flood insurance and the need to lessen the devastating consequences of flooding. FEMA works closely with State and local officials to identify flood hazard areas and flood risks. Floodplain management requirements within high-risk areas, known as Special Flood

Hazard Areas, are designed to prevent new development from increasing the flood threat, and to protect new and existing buildings from anticipated flood events. Because the levees in Reach 2B are not authorized flood control levees, the Project area is within a FEMA-designated 100-year flood hazard zone.

U.S. Army Corps of Engineers

The Corps has nationwide responsibility for flood management. In California, flood management on the San Joaquin River system and other rivers is a combination of the Corps, Reclamation, State, and private projects; all operated under the Corps official flood management plans. The Corps has emergency authority to fight any flood to protect life and property and to rehabilitate Federal flood management facilities that are maintained by State and local entities.

Central Valley Flood Protection Board

The CVFPB was established to accomplish the following:

- Control flooding along the Sacramento and San Joaquin rivers and their tributaries, in cooperation with the Corps. This includes working with all permit requests for construction of improvements of any nature within the limits of a Federal project right-of-way; permit requests are referred to the Corps District Engineer for review (in accordance with the provisions of 33 Code of Federal Regulations (CFR) Section 208.10).
- Cooperate with various agencies of the Federal, State, and local governments in establishing, planning, constructing, operating, and maintaining flood control works.
- Maintain the integrity of the existing flood control system and designated floodways through the CVFPB's regulatory authority by issuing permits for encroachments.

California Department of Water Resources

DWR established the Division of Flood Management in November 1977, although flood forecasting and flood operations had been integral functions of the DWR and its preceding agencies for about a century. Today, the functions of statewide flood forecasting, flood operations, and other key flood emergency response activities are the primary missions of the Division of Flood Management Hydrology and Flood Operations Office. Other components of the Division of Flood Management include Flood Projects Office, Flood Maintenance Office, FloodSAFE Program Management Office, and the Central Valley Flood Planning Office.

The Division of Flood Management, among several others, is carrying out the work of DWR’s California FloodSAFE Initiative program, which partners with local, regional, State, Tribal, and Federal officials in creating sustainable, integrated flood management and emergency response systems throughout California. DWR is responsible for inspecting Federal project levees and has an obligation to prepare a State Plan of Flood Control and Central Valley Flood Protection Plan. Both plans are required to incorporate any modifications to the flood management system anticipated under the Settlement. In

June 2012 the CVFPB adopted the 2012 Central Valley Flood Protection Plan. The plan lays out the goals and objectives to flood protection including ecosystem integration over the following 5 years and includes a vision for long-term flood management over the next 20 to 25 years (DWR 2012).

Lower San Joaquin Levee District

The LSJLD was created in 1955 by a special act of the State Legislature to operate, maintain, and repair levees, bypasses, and other facilities built in connection with the Flood Control Project. The district encompasses approximately 468 square miles (300,000 acres) in Fresno, Madera, and Merced counties. LSJLD is responsible for operation and maintenance and emergency management of State flood control facilities within the district boundaries including 191 miles of levees, channel bottoms, and flood management facilities. The LSJLD is not responsible for operation and maintenance of privately owned levees. Operations and maintenance activities include vegetation management activities, sediment management and removal activities, cleaning of screens and trash racks on facilities, opening and closing gates and flap gates in the bypass systems, and flood watch. Important facilities maintained by the district include the Chowchilla Bypass, the Eastside Bypass, and the Mariposa Bypass.

12.1.5 Levee Evaluations and Flood System Repairs in the Restoration Area

San Joaquin Levee Evaluation Project

Levee evaluations along the San Joaquin River and flood bypasses are being conducted by DWR to assist the SJRRP in assessing flood risks due to levee seepage and stability associated with the release of Restoration Flows. This exploration and evaluation of existing levees within the Restoration Area is being performed under DWR’s San Joaquin Levee Evaluation Project. The evaluation identifies the maximum flow that can be conveyed through the levees without exceeding Corps criteria for levee underseepage and slope stability.

DWR classified levee segments in the Restoration Area into one of three categories representing an increasing priority for the need to complete geotechnical evaluations and levee stability analyses. Priority 1 levees are located in Reach 2A (14.9 miles), the Middle Eastside Bypass (from Sand Slough to the Eastside Bypass Control Structure) (20.6 miles), and the lowest portion of Reach 4A (4.1 miles).

The initial phase of the San Joaquin Levee Evaluation Project included levee evaluations within two Priority 1 study areas – 15 miles of levees in Reach 2A (the Gravelly Ford study area) and 25 miles of levees along the lower portion of Reach 4A and the Middle Eastside Bypass (Middle Eastside Bypass study area). The evaluations required reconnaissance-level geotechnical explorations, soils testing, and seepage and stability analyses at multiple water surface elevations along multiple levee segments. A geomorphic study was used to generate maps and develop a preliminary characterization of the levee foundation conditions. Initial field investigations were then conducted including geophysical surveys, soil borings, and cone penetrometer tests. Review of the geophysical and drilling data informed a second phase of drilling that included hand auger borings along the levee toe. Geotechnical laboratory tests were performed on selected soil samples obtained from these borings to characterize the geotechnical and engineering properties of the subsurface materials. This information was then input into levee seepage and stability models to identify the maximum allowable water surface elevation that can occur on the levees without exceeding Corps criteria for seepage and stability. The seepage and stability modeling evaluated through-levee seepage, underseepage, and landside stability. The results of the seepage and stability modeling were used to identify the controlling failure mechanism in the levee segments and to estimate the highest elevation that water could be placed on the waterside slope of the levee while still meeting seepage and stability criteria.

Results of the Priority 1 levee evaluations for the maximum flows showed that allowable flows in Reach 2A, when considering levee seepage and stability, are over 6,000 cfs throughout the entire reach, and in Reach 4A, the conveyance capacity of the evaluated portion of the reach was over 4,500 cfs. In contrast to Reach 2A and 4A, a few portions of the Middle Eastside Bypass could not convey 4,500 cfs without exceeding Corps criteria for levee seepage and slope stability, including a single 3-mile levee segment which had a capacity less than 1,300 cfs (SJRRP 2016).

Currently, DWR is performing the next steps of the San Joaquin Levee Evaluation Project. DWR is initiating a feasibility-level study on the critical levee segment that initial levee evaluations have shown will exceed Corps criteria for underseepage and DWR is continuing the exploration and evaluations of Priority 2 and 3 levees to inform the SJRRP of future remediation needs. DWR will also coordinate any levee remediation projects with Reclamation to ensure that levee stability improvements are consistent with improvements needed to address agricultural seepage issues. Priority 2 evaluations are currently being performed on about 30 miles of levees in Reach 4B and the Mariposa Bypass and 3 miles on the right bank of Reach 3. The initial explorations, including bore holes, cone penetrometer tests, geophysical surveys, and testing of the soils data has been completed. The next step will be to evaluate the results of the data and plan and implement the next phase of explorations. The initial evaluations for Priority 3 levees are scheduled to start in 2016.

Non-Urban Levee Evaluation Program

In addition to the levee stability evaluations discussed above, DWR has performed geotechnical evaluations in the Restoration Area as part of the Non-Urban Levee Evaluation (NULE) program. The NULE program evaluates Federal Flood Control Project levees (Project levees) and those appurtenant Non-Project levees which protect a basin partially protected by Project levees, or those that may impact the performance of Project levees, in areas where protected populations are less than 10,000.

Subsurface explorations in the Restoration Area were completed in 2012. These explorations consisted of approximately five cone penetrometer tests and one exploratory boring on the levee crest per mile with occasional explorations on the levee toe. A total of 164 cone penetrometer tests and 40 borings were drilled on or along levees in Reaches 2A, 3, and 4A and a total of 125 cone penetrometer tests and 46 borings were drilled along the Eastside Bypass and Chowchilla Bypass canals. Seepage and stability evaluations were also perform on these levees. The NULE assessments are used by the San Joaquin Levee Evaluation Project in areas with priority levees.

Flood System Repair Project

DWR is working with the LSJLD to re-rock 25.5 miles of levee roadways in the Restoration Area to provide allweather access to these levees. This work is being conducted under the Flood System Repair Project, in support of the Central Valley Flood Protection Plan. Improvements to levee roadways will help reduce flood risks by improving the reliability of the levees for levee monitoring during flood events. In addition, DWR is working with the LSJLD to modernize the electronic gate controls for the Chowchilla Bypass, San Joaquin River, Eastside Bypass, and Mariposa Bypass control structures. These modifications will improve the system operations by increasing system reliability and allowing the ability to quickly adjust gate settings for more efficient operations.

SJRRP Channel Capacity Reports

As members of the Channel Capacity Advisory Group, Reclamation, DWR, the Corps, the LSJLD, and the CVFPB determine and update estimates of then-existing channel capacities in the Restoration Area. Then-existing channel capacities in the Restoration Area correspond to flows that would not significantly increase flood risk from Restoration Flows. The most recent SJRRP Channel Capacity Report (SJRRP 2016) provides the following estimates for then-existing channel capacities in the Restoration Area (Table 12-2).

Table 12-2.
Then-Existing Channel Capacities in the Project Area and Vicinity

Reach	Recommended Then-Existing Channel Capacity (cfs)[a]	Study that Determined the Then-Existing Capacity
Reach 2A	6,000[b]	Geotechnical assessment
Reach 2B	1,120	In-channel flows
Reach 3	2,860[c]	In-channel flows
Reach 4A	2,840[d]	Geotechnical assessment and in-channel flows
Reach 4B1	Not Analyzed	-
Reach 4B2	930	In-channel flows
Middle Eastside Bypass	580[d]	Geotechnical assessment
Lower Eastside Bypass	2,890	In-channel flows

Source: SJRRP 2016

Notes:

[a] Then-existing channel capacity is based on levee stability only and does not consider limitations to Restoration Flows related to agricultural seepage.

[b] Capacity not assessed for flows greater than 6,000 cfs. Restoration Flows are limited to 2,140 cfs due to agricultural seepage.

[c] Restoration Flows are limited to 900 cfs due to agricultural seepage.

[d] Restoration Flows are anticipated to be limited to 300 cfs due to agricultural seepage.

Key:
cfs = cubic feet per second

12.2 Regulatory Setting

The Federal, State, and regional and local regulatory setting of the Project as it pertains to flood management is described below.

12.2.1 Federal

The Federal regulatory setting describes Executive Order (EO) 11988, and Section 14 of the Rivers and Harbors Act (RHA).

Executive Order 11988 (Flood Hazard Policy)

EO 11988 is a flood hazard policy for all Federal agencies that manage Federal lands, sponsor Federal projects, or provide Federal funds to State or local projects. It requires that all Federal agencies take necessary action to reduce the risk of flood loss; restore and preserve the natural and beneficial values served by floodplains; and minimize the impacts of floods on human safety, health, and welfare. Specifically, EO 11988 dictates that all Federal agencies avoid construction or management practices that would adversely affect floodplains unless that agency finds no practical alternative, and the proposed action has been designed or modified to minimize harm to or within the floodplain.

Rivers and Harbors Act Section 10

Section 10 of the Rivers and Harbors Act (33 United States Code 401 et seq.) requires authorization from the Corps for construction of any structure over, in, or under navigable waters of the United States.

Rivers and Harbors Act (Section 408)

Section 14 of the RHA (commonly known as Section 408) was approved by the Federal Government on March 3, 1899 (33 United States Code 408). The act provides that the Secretary of the Army, on the recommendation of the Chief of Engineers, may grant permission for the temporary occupation or use of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States. Major alterations to a Federal flood control project, including alterations to channels and levees that change the Federal project’s authorized geometry or the hydraulic capacity, would require a Corps permit.

Clean Water Act Section 404

(See Chapter 14.0, “Hydrology - Surface Water Resources and Water Quality.”)

12.2.2 State of California

The State regulatory setting describes the Central Valley Flood Protection Act of 2008 and the CVFPB Encroachment Permit.

Central Valley Flood Protection Act of 2008

The Flood Protection Act of 2008 has strengthened flood protection regulations in California. This legislation requires DWR and CVFPB to prepare and adopt a Central Valley Flood Protection Plan. The legislation also establishes certain flood protection requirements for local land use decision-making based on the Central Valley Flood Protection Plan. This law sets new standards for flood protection for the San Joaquin

Valley area. It requires an urban level of flood protection necessary to withstand a 1 in 200 chance of a flood event occurring in any given year (200-year flood) for areas developed or planned to have a population of at least 10,000. Under the Central Valley Flood Protection Plan, the State is also considering structural and nonstructural options for rural-agricultural and small communities for protection from a 100-year (1% annual chance) flood.

Central Valley Flood Protection Board Encroachment Permit

Under Title 23 of the California Code of Regulations, the CVFPB issues encroachment permits to maintain the integrity and safety of flood control project levees and floodways that were constructed according to flood control plans adopted by CVFPB or the California Legislature. The CVFPB has jurisdiction over the levee section, the waterward area between project levees, a 10-foot-wide strip adjacent to the landward levee toe, within 30 feet of the top of the banks of unleveed project channels, and within designated floodways adopted by the CVFPB. Activities outside of these limits that could adversely affect the flood control project also fall under the jurisdiction of the CVFPB. In accordance with the provisions of Title 33, CFR Section 208.10, all permit requests for construction of improvements of any nature within the limits of a Federal project right-of-way would be referred to the Corps District Engineer for review.

Project-level actions will require work along the San Joaquin River in areas that may be subject to Title 23 because the river is managed for flood control and thus contains features subject to the jurisdiction of CVFPB. The San Joaquin River is a regulated stream and the proposed action could have an effect on the flood control functions of project levees just east and north of the Chowchilla Bifurcation Structure or downstream project levees. Project proponents will secure encroachment permits, as needed, to satisfy Title 23 before performing any work along relevant reaches of the San Joaquin River that contain flood control features subject to CVFPB jurisdiction.

12.2.3 Regional and Local

Local plans and policies include those designated in county general plans.

Fresno County General Plan

The Fresno County General Plan Policy Document (Fresno County 2000) outlines several policies for flood management.

- Policy HS-C.2 requires that the design and location of dams and levees be in accordance with applicable design standards and specifications and accepted design and construction practices.
- Policy HS-C.6 indicates that the County shall promote flood control measures that maintain natural conditions within the 100-year floodplain of rivers and streams and, to the extent possible, combine flood control, recreation, water quality, and open space functions.
- Policy HS-C.7 indicates that the County shall continue to participate in the Federal Flood Insurance Program by ensuring compliance with applicable requirements.

- Policy HC-C.10 required that placement of structures and/or floodproofing be done in a manner that will not cause floodwaters to be diverted onto adjacent property, increase flood hazards to other property, or otherwise adversely affect other property.

Madera County General Plan

The Madera County General Plan Policy Document (Madera County 1995) outlines several policies for flood management.

- Policy 6.B.1 requires flood-proofing of structures in areas subject to flooding.
- Policy 6.B.3 restricts uses in designated floodways to those that are tolerant of occasional flooding and do not restrict or alter flow of flood waters.
- Policy 6.B.4 requires that development within areas subject to 100-year floods be designed and constructed in a manner that will not cause floodwaters to be diverted onto adjacent property or increase flood hazards to other areas.

12.3 Environmental Consequences and Mitigation Measures

12.3.1 Impact Assessment Methodology

This section describes the impact assessment methodology for hydrology – flood management resources in the Project area. Assessment included the application of quantitative modeling results and qualitative assessments. The assessment includes review of hydraulic modeling results performed using HEC-RAS and SRH-1D models. These models were used to forecast stages and channel and floodplain velocities for the Project alternatives. The evaluation of flood management impacts considers how proposed changes associated with Project alternatives would affect flooding in Reach 2B and the Restoration Area.

12.3.2 Significance Criteria

The thresholds of significance for impacts are based on the Environmental Checklist Form in Appendix G of the California Environmental Quality Act (CEQA) Guidelines, as amended. These thresholds also encompass the factors taken into account under the National Environmental Policy Act (NEPA) to determine the significance of an action in terms of its context and the intensity of its effects. Impacts to flood management resulting from the Project would be significant if they would cause any of the following:

- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure or a levee or dam, including:
  - Increase risk of levee failure due to underseepage, through-seepage, or associated landside slope stability mechanisms (this is described in Chapter 13.0, "Hydrology–Groundwater").
  - Increase risk of levee failure due to erosion or associated landside slope stability mechanisms.

- Substantially reduce opportunities for levee and flood system facilities inspection and maintenance.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site.
- Place within a 100-year flood hazard area structures that would impede or redirect flood flows.
- Place housing within a 100-year flood hazard area, as mapped on a Federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map.

Significance standards are relative to both existing conditions (2009) and future conditions (2035) unless stated otherwise.

12.3.3 Impacts and Mitigation Measures

This section provides a project-level evaluation of direct and indirect effects of the Project Alternatives on flood management. It includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. The analysis is organized by project alternative with specific impact topics numbered sequentially under each alternative. With respect to flood management, the environmental impact issues and concerns are:

1. Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.
2. Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.
3. Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.
4. Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.

Other flood-related issues covered in the Program Environmental Impact Statement/Report (PEIS/R) are not covered here because they are programmatic in nature and/or are not relevant to the Project area. The Project does not involve the construction or placement of any housing within a 100-year flood hazard zone. Therefore, this impact is not discussed further.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the San Joaquin River Restoration Program (SJRRP) would be implemented, including habitat restoration, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, these activities would not achieve the Settlement goals. This section describes the impacts of the No-Action alternative. The analysis is a comparison to existing conditions, and no mitigation is required for No-Action.

Impact FLD-1 (No-Action Alternative***): Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.*** Under the No-Action Alternative, the Project would not be implemented, improvements in Reach 2B flood control structures or levees would not occur, and Project areas protected by local levees would remain within the FEMA-designated 100-year flood hazard area. Under existing conditions, the effective flood capacity of Reach 2B is less than the design capacity of 2,500 cfs, which implies that the channel capacity of Reach 2B has been reduced since construction of the existing levees. This trend in decreasing channel capacity has also been found in downstream reaches. Reach 2B can functionally pass about 1,600 cfs of San Joaquin River flood flows with the boards out at Mendota Dam, and because of this, San Joaquin River flood flows that may otherwise have been routed through Reach 2B are instead routed through the Chowchilla Bypass. Therefore, the flood system is not operating as envisioned in the flood control manual, potentially causing more flood damage to the system and adjacent landowners. This trend of decreasing channel capacity may continue under the No-Action Alternative. This impact is **potentially significant**. No mitigation is required for No-Action.

Impact FLD-2 (No-Action Alternative): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.*** Under the No-Action Alternative, the Project would not be implemented and there would be no interruptions to flood system facility inspections and maintenance in Reach 2B. Restoration Flows could cause an increase in sediment deposition above the Chowchilla Bypass control structures requiring additional maintenance activities at this location. This is only one of several control structures maintained in the flood control system and increases in maintenance activities at this location are expected to be minor compared to maintenance requirements for the overall flood control system. This impact would be **less than significant**.

Impact FLD-3 (No-Action Alternative): ***Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.*** Under the No-Action Alternative, existing levees and floodplain width would be maintained. There would not be a change to existing drainage patterns that would affect the rate of surface water runoff or infiltration. There would be **no impact**.

Impact FLD-4 (No-Action Alternative): ***Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.*** Under the No-Action Alternative, the Project would not be implemented and no additional Project structures would be placed within the 100-year flood hazard area. No actions would be undertaken that would cause impacts under the No-Action Alternative. There would be **no impact.**

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities, including a Compact Bypass channel, a new levee system encompassing the river channel with a narrow floodplain, and the South Canal. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure with fish passage facility and fish screen, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

Impact FLD-1 (Alternative A*): Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.* The documented existing design capacity of Reach 2B is about 2,500 cfs. Compared to the No-Action Alternative, Alternative A would increase the capacity of Reach 2B to 4,500 cfs with 3 feet of freeboard. This increase in conveyance capacity in Reach 2B may have an indirect effect of providing flood management agencies additional flexibility in how flood flows are managed in the lower San Joaquin River system, if deemed appropriate.[2]

The existing design capacity of Reach 3 is 4,500 cfs. Reach 3 can receive flood flow from the Kings River system through the James Bypass and Fresno Slough or can receive flood flow from the San Joaquin River system through Reach 2B. According to flood management guidelines, water from the Kings River system has priority to use available capacity in the San Joaquin River below Mendota Pool. For example, if 4,500 cfs of flow is conveyed through Fresno Slough, there would be no flood flows conveyed through Reach 2B because there would be no additional capacity in Reach 3. If there is a reduced need for flood flow conveyance through Fresno Slough, Reach 2B could be used to convey flood flows. Current flood management operational strategies seek to maximize the amount of flood flows conveyed through the Chowchilla Bypass to minimize potential flood impacts to the City of Firebaugh and to landowners along Reach 3.

The increase in Reach 2B capacity would reduce the risk of flooding in Reach 2B, a beneficial effect for Reach 2B. The Project would build new levees to Corps standards, which would also be a beneficial effect associated with flood management in Reach 2B. Under Alternative A, the chance of a levee failure in Reach 2B during a large storm event would decrease. Although not observed during recent large flood events, a levee failure in Reach 2B would reduce potential levee failure in reaches downstream of Reach 2B. To the extent that this could occur, reducing the probability of Reach 2B levees failing in the future could increase the probability of downstream levee failure and flooding. However, the likelihood of this happening is low and downstream interests cannot claim flood protection benefits by relying on failure of upstream facilities, nor can they claim they are harmed if the upstream failure does not occur.

[2] Flood management agencies have ultimate discretion in directing flood flows. The Flood Control Project is operated to minimize flood impacts throughout the flood protection area. Prior to use of the additional capacity in Reach 2B, the flood management agency would evaluate flood operations from a system-wide perspective.

The mechanism for increased probability of levee failure would be from an increased frequency of large flows in downstream reaches. Without the Project, only flows up to 2,500 cfs from Reach 2A or flows up to 4,500 cfs from Fresno Slough could be directed through Reach 2B. However, under Alternative A, up to 4,500 cfs of flow could be routed from Reach 2A into Reach 3. Therefore, under Alternative A, flows greater than 2,500 cfs but within the Reach 3 capacity could occur more frequently. Potential levee damage from the increased frequency of larger flows would primarily be from erosion, and Program monitoring and maintenance efforts would repair erosion on a regular basis to lessen the likelihood of this leading to levee failures in the Program Restoration Area downstream of Reach 2B.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). To evaluate the potential for redirected flood risk, flows in Reach 3 with and without the restoration project (inclusive of both Program and Project elements) were estimated for the period from October 1921 through September 30, 2003, using data from the San Joaquin River Restoration Daily Flow Model developed in RiverWare (Reclamation 2012). These data were used to calculate the daily average flow duration and annual maximum flows from Reach 2B to Reach 3. The flow duration curve is a flow exceedance probability curve (Figure 12-3), which shows the percentage of time that the stream flow is likely to equal or exceed a flow value of interest. For example, in Figure 12-3, a flow of 100 cfs from Reach 2B to Reach 3 is exceeded 80 percent of the time under existing conditions and 98 percent of the time under Restoration Flow conditions. In other words, under Restoration Flows, flow from Reach 2B to Reach 3 will be equal to or greater than 100 cfs, 98 percent of the time. A flow of 4,500 cfs (the current capacity of Reach 3) is exceeded less than 0.5 percent of the time under existing conditions. This would increase to about 2.5 percent of the time under Restoration Flows.

Annual maximum flow is the maximum flow that occurs within any year. It is the flow typically used for the design of levees and other flood control facilities. Though the maximum instantaneous flow rather than the daily average flow is usually used for design on large rivers, such as the San Joaquin River, the two are typically similar. Figure 12-4 shows the flood frequency curve for Reach 3 with and without Restoration Flows. With Restoration Flows, the size of smaller events (less than a 2 percent annual exceedance probability or 50-year event) would increase but for larger, less frequent, flood events the flow would decrease. For example, the 5-year event (20 percent annual exceedance probability) would increase from a little over 2,000 cfs to over 4,000 cfs with Restoration Flows, but the 1 percent annual exceedance flow (100-year event) would decrease from 9,000 cfs to 7,000 cfs.

Because the Project will increase the channel capacity and improve levees in Reach 2B, flood hydrographs, and possibly, flood damages have the potential to translate downstream to lower reaches of the river. The PEIS/R analyzed the potential for this indirect effect and concluded that the change in damages due to this translation was minor and therefore the impacts were less than significant. However, due to the lack of information on levee conditions, the PEIS/R required project-level analysis of the potential to impede or transfer flood risk downstream.

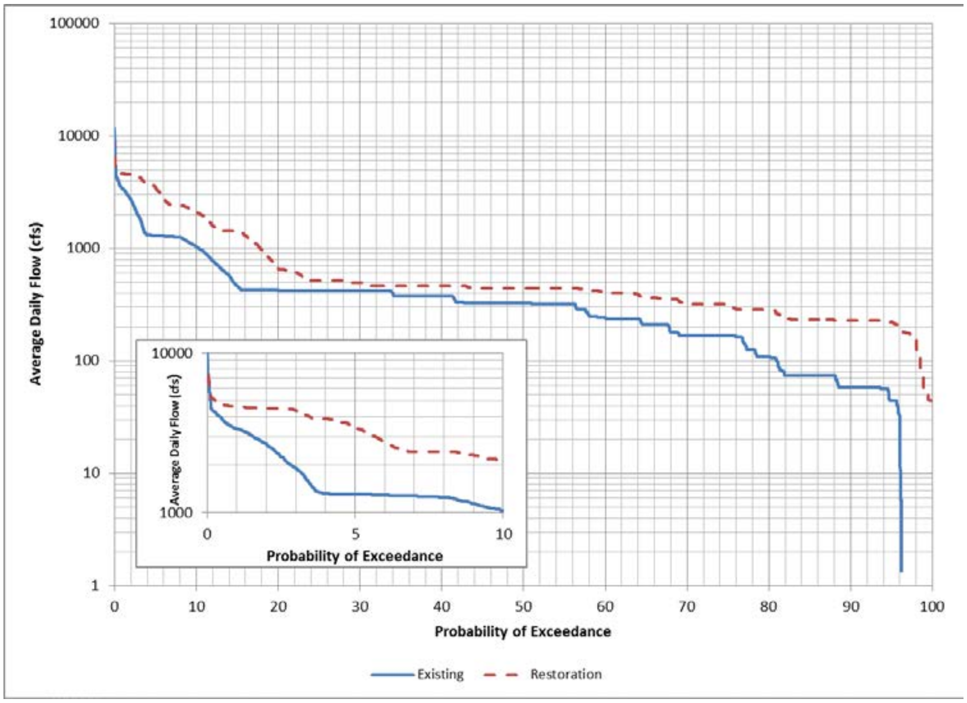


Figure 12-3.
Flow Duration Curve for Flows from Reach 2B

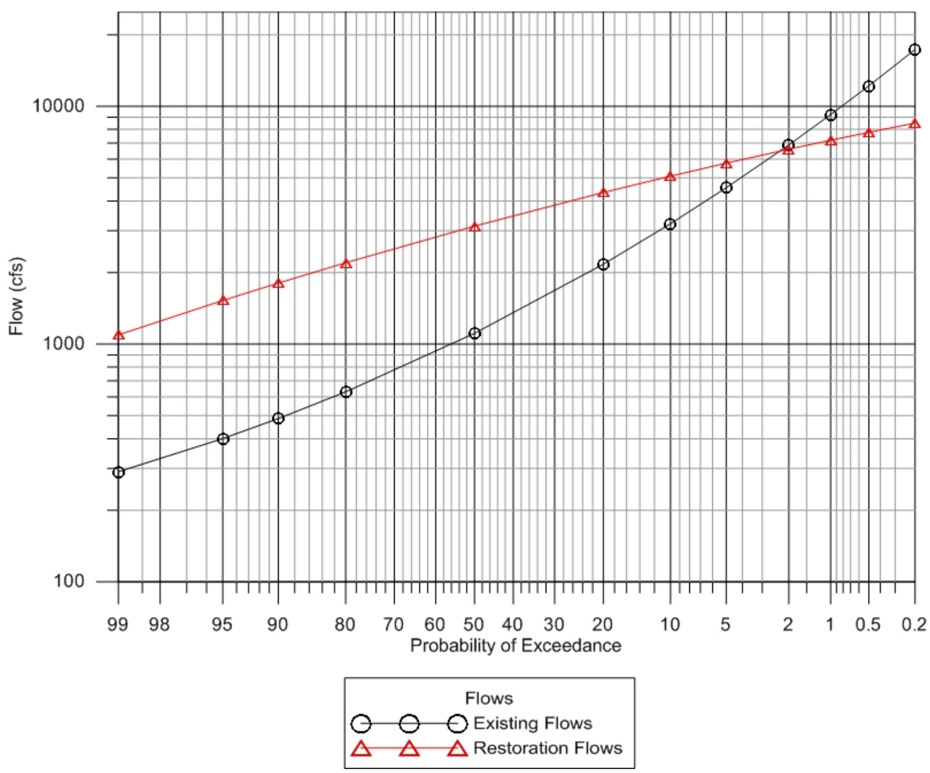


Figure 12-4.
Flood Frequency Curve for Flows from Reach 2B

SJRRP conducted a flood risk assessment on the translation of flood risk from Reach 2B to reaches downstream, *i.e.*, to Reach 3 and Reach 4A. The objective of the analysis was to determine if damages would change based on changes in the flood hydrographs and if the likely failure points for levees used in the PEIS/R evaluation were reasonable. The analysis included a comparison of flood hydrographs at four index points in Reaches 3 and 4A, an evaluation of flood damages at these locations, and an evaluation of the updated levee data in Reach 3 and Reach 4A. The study concluded that, based on a comparison of changes to flood hydrographs, there would be little to no increase in damages – the one area that showed a slight increase in damages was likely due to perturbation effects in the model – and therefore redirected flood impacts would be minor. Furthermore, the risk analysis also evaluated information from recently completed levee evaluations including the drilling information and seepage and stability analysis in Reaches 2A, 3, and 4A. A review of the levee evaluations concluded that the likely failure points for these levees that were used in the PEIS/R were reasonable and conservative.

As described in the PEIS/R (and Section 2.2.10 of this EIS/R), Restoration Flows would be maintained at or below estimates of the then-existing channel capacity within the reach that conveys the flow. In addition, seepage projects and levee stability projects have been identified in the Restoration Area where potential seepage impacts or levee stability would otherwise cause a constraint in Restoration Flows. Restoration Flows would not increase in the river reaches until Reclamation, through the seepage efforts and through the channel capacity report process, determines that such flows would not damage adjacent landowners or impact levee stability. Erosion would also be monitored and maintenance would occur, or Restoration Flows would be reduced, as necessary, to avoid erosion-related impacts. These avoidance and minimization measures implemented by the Program will reduce the risk of levee failure during moderate flows. Because of the avoidance and minimization measures that target potential adverse effects from moderate flows, and because the frequency of very high flows would be reduced, and because recent flood risk assessments by DWR have found little to no increase in flood damages in downstream reaches, the impact is considered **less than significant**.

Impact FLD-2 (Alternative A): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.*** LSJLD is responsible for operation and maintenance and emergency management of State flood control facilities within the Project vicinity including maintenance of levees, channel bottoms, and flood management facilities. Operations and maintenance activities include vegetation management activities, sediment management and removal activities, cleaning of screens and trash racks on facilities, opening and closing gates and flap gates in the bypass systems, and flood watch. Important facilities maintained by the district include the Chowchilla Bypass, the Eastside Bypass, and the Mariposa Bypass. The LSJLD is not responsible for operation and maintenance of privately owned levees.

Compared to the No-Action Alternative, construction activities may temporarily limit access to levees and facilities for maintenance and inspection staff. However, construction activities would not completely impede inspection and maintenance activities; minor coordination of such activities would be required. New levees that are constructed would be accessible. Therefore, potential short-term effects would be negligible.

The Project includes long-term operations, maintenance, and monitoring of the proposed facilities and features (see Section 2.2.4). Levees would require access for vegetation management, levee inspections, and levee restoration. Control structures would require access for annual operating maintenance for control gates, lubricating the fittings, greasing and inspecting the motors, replacing parts and equipment, in-channel sediment removal in the structure vicinity, and cleaning the trash rack. Fish passage facilities, fish screens, and fish barriers would also need to be inspected, operated, and maintained. Monitoring activities would require access for physical and nonphysical activities within the Project area, including flow monitoring, groundwater level monitoring, aerial and topographic surveys, vegetation surveys, sediment mobilization monitoring, and monitoring of passage and screening effectiveness. Implementation of these operation, maintenance, and monitoring activities is part of the Project and access would be provided to maintenance and inspection staff. Therefore, long-term access and opportunities for levee and flood system facilities inspection and maintenance would be provided.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). This impact would be **less than significant**.

Impact FLD-3 (Alternative A): ***Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.*** Under Alternative A, setback levees would be constructed to widen the floodplain. The floodplain would also be graded in locations to set it at the elevation desired for restoration. Compared to the No-Action Alternative, these activities would alter local drainage patterns and possibly affect existing drainage outside the mainstem of the river by blocking channels or by redirecting overland flow that otherwise would have drained into the Project footprint. This would potentially cause ponding on the landward side of levees. However, the construction of new levees would include seepage control measures, inspection trenches, maintenance roads, and drainage trenches to direct off-site drainage, as well as the realignment or modification of existing drainage channels (see Section 2.2.4). Surface drainage ditches would only be intended to capture and direct runoff; they are not intended to address groundwater seepage or through-levee seepage. These actions would reduce potential effects to negligible levels.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraph (i.e., the comparison of Alternative A to the No-Action Alternative). This impact would be **less than significant.**

Impact FLD-4 (Alternative A): ***Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.*** The major facilities that would be constructed within the 100-year flood hazard area under Alternative A include the Compact Bypass channel, Mendota Pool Dike, modifications to the San Mateo Avenue crossing, a diversion structure for the South Canal, modifications to the Chowchilla Bifurcation Structure, and fish passage facilities.

Compared to the No-Action Alternative diversion structures and fish passage facilities could create localized backwater and redirection effects. These effects would be considered during Project design. Structures would be designed in general accordance with Reclamation Design Standards No. 3 for water conveyance facilities, fish facilities, and roads and bridges, applicable design codes, and commonly accepted industry standards. Levee design would be based on the Corps *Engineer Manual 1110-2-1913 Design and Construction of Levees* guidelines (Corps 2000a) and *Engineer Manual 1110-2-301 Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, & Embankment Dams* (Corps 2000b).

Localized backwater and redirection effects at Project structures would be considered during design of levee heights. Levees would be designed to maintain 3 feet of freeboard on the levees at 4,500 cfs (see Section 2.2.4). Therefore, flooding effects would be negligible.

When comparing Alternative A to existing conditions, impacts would be similar to those described in the preceding paragraphs (i.e., the comparison of Alternative A to the No-Action Alternative). This impact would be **less than significant.**

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features including a Compact Bypass channel, a new levee system with a wide, consensus-based floodplain encompassing the river channel, the Mendota Pool Control Structure, and the Compact Bypass Control Structure with fish passage facility and fish screen. Other key features include construction of a fish passage facility at the San Joaquin River control structure at the Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass Control Structure), and removal of the San Mateo Avenue crossing. Construction activity is expected to occur intermittently over an approximate 157-month timeframe.

Impact FLD-1 (Alternative B*): Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.* Refer to Impact FLD-1 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A with the following exception. The Compact Bypass design in Alternative B includes fewer grade control structures than the other alternatives, which would initiate channel bed erosion in Reach 2B to remove sediment that has been deposited in the San Joaquin River arm of Mendota Pool. The channel bed erosion in Reach 2B would result in sediment deposition in the Reach 3 channel for approximately 1 mile downstream of the Compact Bypass (RM 203). The maximum estimated water surface increase resulting from this sedimentation is approximately 0.25 feet. Levee improvements would be extended in the upper portion of Reach 3 to approximately RM 203 to offset this water surface increase if needed to maintain 3 feet of freeboard. This impact would be **less than significant**.

Impact FLD-2 (Alternative B): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.*** Refer to Impact FLD-2 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-3 (Alternative B): ***Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.*** Refer to Impact FLD-3 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-4 (Alternative B): ***Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.*** Refer to Impact FLD-4 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A, with the following exceptions. The major facilities that would be constructed within the 100-year flood hazard area include the Compact Bypass channel, the Mendota Pool Control Structure, the Compact Bypass Control Structure, and fish passage facilities. The San Mateo Avenue crossing would be removed. Localized backwater and redirection effects at Project structures would be considered during design of levee heights. Therefore, flooding effects would be negligible. This impact would be **less than significant.**

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a new levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, fish barrier below Fresno Slough Dam, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe.

Impact FLD-1 (Alternative C*):* ***Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.*** Refer to Impact FLD-1 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. This impact would be **less than significant**.

Impact FLD-2 (Alternative C): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.*** Refer to Impact FLD-2 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-3 (Alternative C): ***Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.*** Refer to Impact FLD-3 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-4 (Alternative C): ***Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.*** Refer to Impact FLD-4 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A, with the following exceptions. The major facilities that would be constructed within the 100-year flood hazard area include Fresno Slough Dam, Short Canal control structure, fish passage facilities, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. The new dam on Fresno Slough would back up Fresno Slough to a similar level as it is presently backed up by Mendota Dam. The Fresno Slough Dam would have a reinforced concrete spillway. The spillway structure would be comprised of multiple gates, which serve to control the flow of water from the Mendota Pool to the San Joaquin River (see Section 2.2.7). Therefore, flooding effects would be negligible. This impact would be **less than significant.**

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a new levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, a fish barrier below Fresno Slough Dam, the North Canal bifurcation structure with fish passage facility and fish screen, removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 158-month timeframe.

Impact FLD-1 (Alternative D): ***Expose People or Structures to a Significant Risk of Loss, Injury, or Death Involving Flooding.*** Refer to Impact FLD-1 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-2 (Alternative D): ***Substantially Reduce Opportunities for Levee and Flood System Facilities Inspection and Maintenance.*** Refer to Impact FLD-2 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-3 (Alternative D): ***Substantially Alter Existing Drainage Patterns or Substantially Increase the Rate or Amount of Surface Runoff in a Manner Which Would Result in Flooding On- or Off-Site.*** Refer to Impact FLD-3 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. This impact would be **less than significant.**

Impact FLD-4 (Alternative D): ***Placement of Structures Within a 100-Year Flood Hazard Area that Would Adversely Impede or Redirect Flood Flows.*** Refer to Impact FLD-4 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A, with the following exceptions. The major facilities that would be constructed within the 100-year flood hazard area include Fresno Slough Dam, the North Canal bifurcation structure, and fish passage facilities. The riverside control structure of the Chowchilla Bifurcation Structure and the San Mateo Avenue crossing would be removed. Portions of the Main Canal and Helm Ditch would be relocated. The new dam on Fresno Slough would back up Fresno Slough to a similar level as it is presently backed up by Mendota Dam. The Fresno Slough Dam would have a reinforced concrete spillway. The spillway structure would be comprised of multiple gates, which serve to control the flow of water from the Mendota Pool to the San Joaquin River (see Section 2.2.8). Therefore, flooding effects would be negligible**.** This impact would be **less than significant.**

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13.0 Hydrology – Groundwater

This section describes the environmental and regulatory settings of groundwater, including the environmental consequences and mitigation, as they pertain to implementation of Project alternatives. Groundwater resources describe the water resources related to water flowing in the subsurface through porous sediments.

13.1 Environmental Setting

The Project area is in Fresno and Madera counties, near the town of Mendota, California, as shown on Figure 1-2 of Chapter 1.0, "Introduction." This area is located above the San Joaquin Valley Groundwater Basin.

13.1.1 Regional Setting

The San Joaquin Valley Groundwater Basin makes up the southern two-thirds of the 400-mile-long, northwest trending asymmetric trough of the Central Valley regional aquifer system in the southern extent of the Great Valley Geomorphic Province. As defined in Bulletin 118, California's Groundwater (California Department of Water Resources [DWR] 2003), the San Joaquin Valley Groundwater Basin is comprised of two hydrologic regions, which are divided by the San Joaquin River near Reach 2B: the San Joaquin River hydrologic region to the north and the Tulare Lake hydrologic region to the south; therefore, the Project area lies within both hydrologic regions.

Groundwater Resources of San Joaquin River Hydrologic Region

The San Joaquin River hydrologic region is heavily groundwater-reliant, with groundwater making up approximately 36 percent of the annual supply for agricultural and urban uses (DWR 2014a). The San Joaquin River hydrologic region consists of surface water basins draining into the San Joaquin River system, from the Cosumnes River basin on the north through the southern boundary of the San Joaquin River watershed. Aquifers in the San Joaquin Valley Groundwater Basin are thick and typically extend to depths of up to 800 feet.

Groundwater in the San Joaquin River hydrologic region historically flowed from the valley flanks to the axis of the valley during predevelopment conditions, then north toward the Delta. In the 1920s, development of a deep-well turbine pump and increased availability of electricity led to expansion of agriculture, and ultimately declining groundwater levels between 1920 and 1950 (DWR 2003). Groundwater pumping and recharge from imported irrigation water have resulted in a change in regional flow patterns. As described in the Program Environmental Impact Statement/Report (PEIS/R) (San Joaquin River Restoration Program [SJRRP] 2011, page 12-4), flow largely occurs from areas of recharge towards areas of lower groundwater levels. Vertical movement of water in the aquifer has been altered in this region as a result of thousands of wells constructed with perforations above and below the confining unit (Corcoran Clay

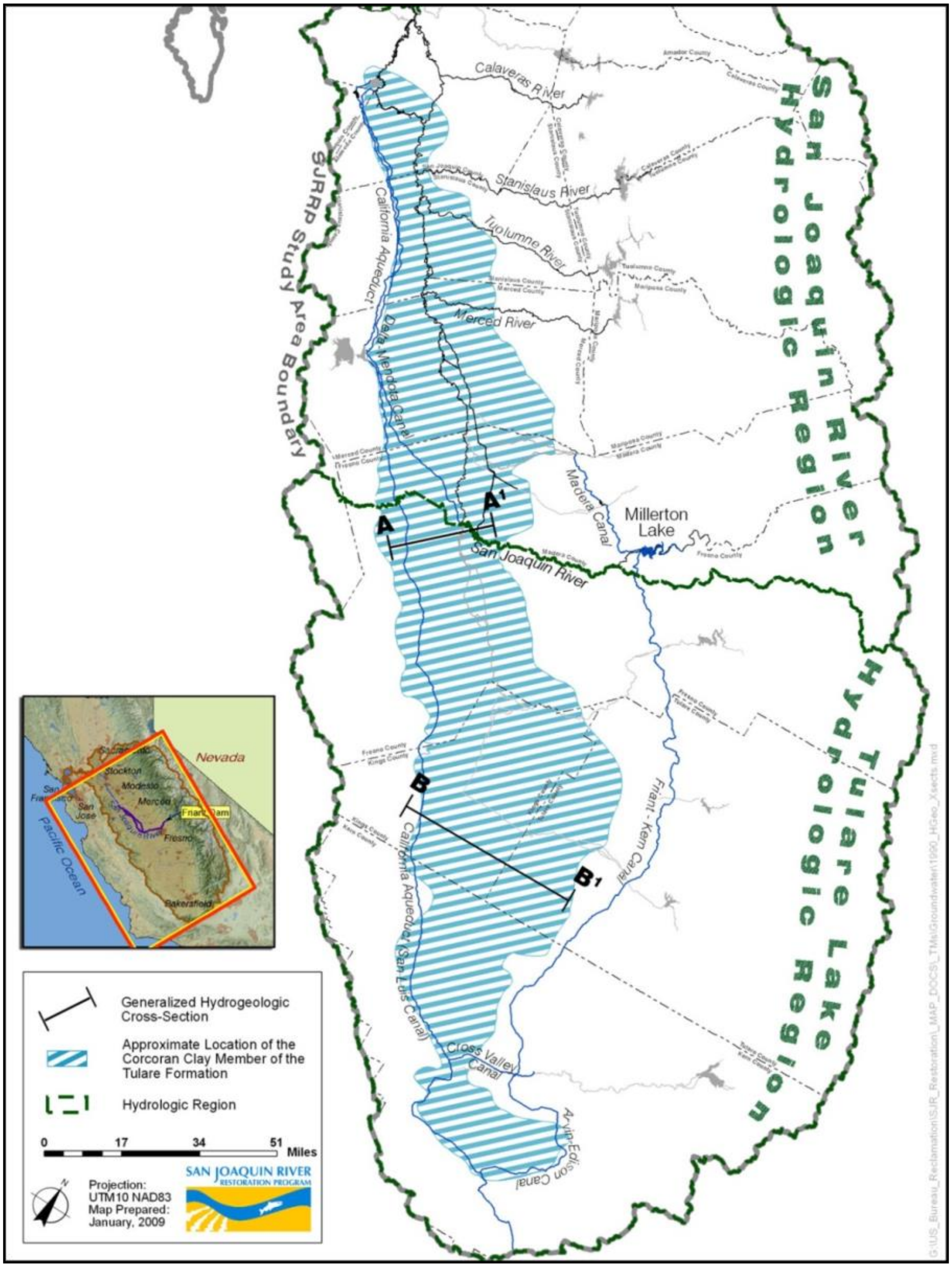
Member), where present, providing a direct hydraulic connection. This increase in vertical flow may have been partially offset by a decrease in vertical flow resulting from the inelastic compaction of fine-grained materials in the aquifer system, which occurs largely due to deep groundwater pumping. The approximate extent of the Corcoran Clay is illustrated on Figure 13-1.

The aquifer system of the San Joaquin Valley Groundwater Basin is divided into two major aquifers: an unconfined to semiconfined aquifer above the Corcoran Clay, a thick zone of clay deposited as part of the sequence of lacustrine and marsh deposits underlying Tulare Lake, and a confined aquifer beneath the Corcoran Clay. The unconfined to semiconfined aquifer can be divided into three hydrogeologic units based on the source of the sediment: Coast Range alluvium, Sierra Nevada sediments, and flood-basin deposits (see Figures 13-1 and 13-2).

The Coast Range alluvial deposits are derived largely from the erosion of marine rocks from the Coast Range. These deposits are up to 850 feet thick along the western edge of the valley and taper off to the east as they approach the center of the valley floor. The alluvial deposits contain a large proportion of silt and clay, are high in salts, and also contain elevated concentrations of selenium and other trace elements. The Sierra Nevada sediments on the eastern side of the region are derived primarily from granitic rock and consist of predominantly well-sorted micaceous sand. These deposits make up most of the total thickness of sediments along the valley axis and gradually thin to the west until pinching out near the western boundary. The Sierra Nevada sediments are relatively permeable with hydraulic conductivities three times the conductivities of the Coast Range deposits. Flood-basin deposits are relatively thin and were derived in recent time from sediments of the Coast Ranges to the west and from sediments of the Sierra Nevada to the east. These deposits occur along the center of the valley floor and consist primarily of moderately to densely compacted clays ranging between 5 and 35 feet thick.

On a regional scale, the Corcoran Clay divides the groundwater system, ranges from zero to 160 feet thick, and is found between 80 and 400 feet below the land surface. The confined aquifer is overlain by the Corcoran Clay Member of the Tulare Formation and consists of mixed origin sediments.

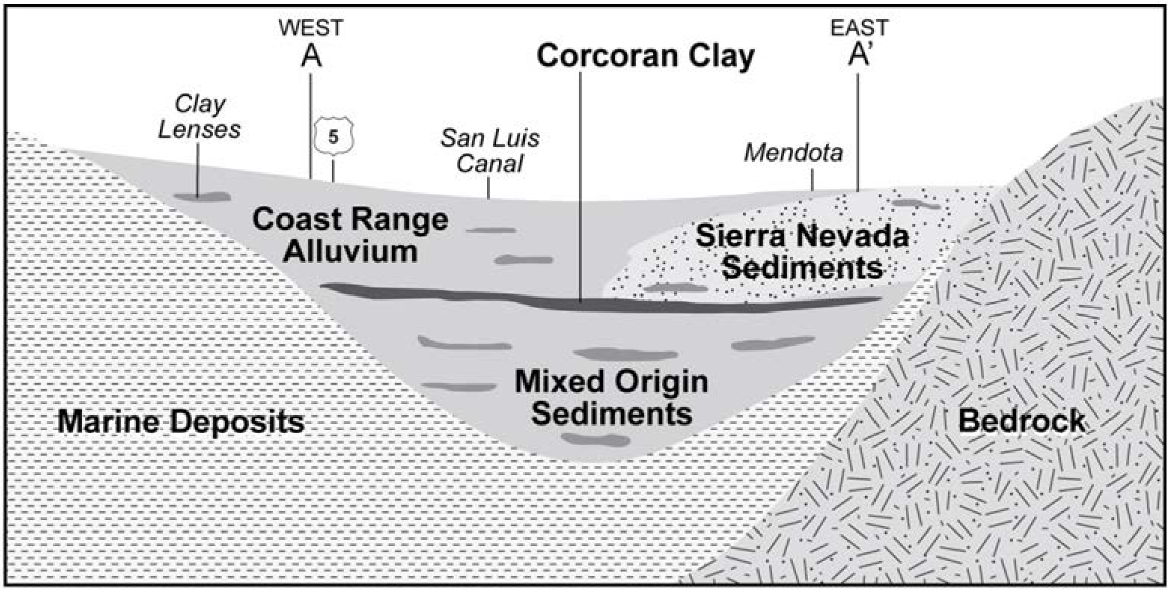
The semiconfined aquifer system of the San Joaquin Valley has historically been recharged by mountain rain and snowmelt along the valley margins. Recharge has generally occurred by stream seepage, deep percolation of rainfall, and subsurface inflow along basin boundaries. As agricultural practices expanded in the region, recharge was augmented with deep percolation of applied agricultural water and seepage from the distribution systems used to convey this water. Recharge of the lower confined aquifer consists of subsurface inflow from the valley floor and foothill areas to the east of the eastern boundary of the Corcoran Clay Member. Present information indicates that the clay layers, including the Corcoran Clay, are not continuous in some areas, and some seepage from the semiconfined aquifer above does occur through the confining layer.



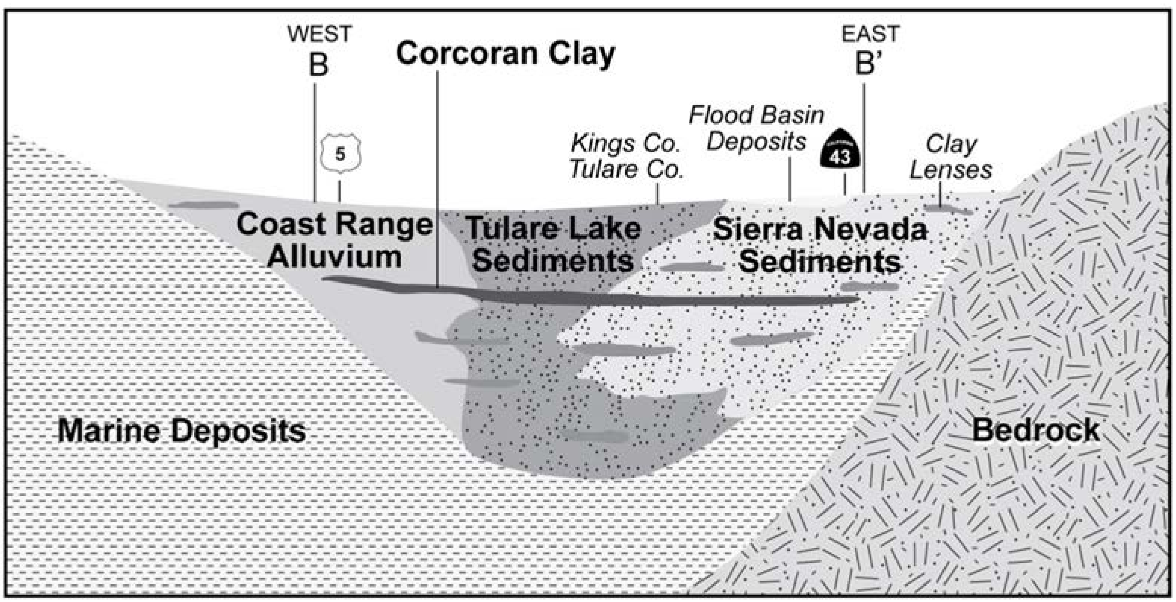
Source: SJRRP 2011

Figure 13-1.
Approximate Boundary of Corcoran Clay and Transect Lines for Hydrogeologic Cross Sections

San Joaquin River Hydrologic Region



Tulare Lake Hydrologic Region



Source: SJRRP 2011

Figure 13-2.
Generalized Hydrogeologic Cross Sections in San Joaquin River and Tulare Lake Hydrologic Regions

The decline in groundwater levels between 1920 and 1950 was as much as 40 to 80 feet in the east side and up to 30 feet in the west side of the San Joaquin River hydrologic region. In 1967, the California Aqueduct replaced groundwater as the primary source of irrigation supply to the area south of Mendota, and consequently, this area became less reliant on groundwater (DWR 2003). However, as illustrated on Figure 13-3, groundwater pumping continued to increase through time as the acreage of irrigated agriculture continued to increase.

Land subsidence is the lowering of the land-surface elevation due to changes in the subsurface. Four types of land subsidence that occur in the San Joaquin Valley include: aquifer-system compaction due to groundwater level decline, near-surface hydrocompaction, subsidence due to fluid withdrawal from oil and gas fields, and subsidence caused by deep-seated tectonic movements (Sneed et al. 2013). Groundwater level decline along with surface hydrocompaction are the primary causes of land subsidence in the San Joaquin Valley. Maximum land subsidence rates occurred in the 1960s with historic lows in the San Joaquin Valley Groundwater Basin exceeding 30 feet. The southern and western areas of the valley were most affected. Figure 13-4 illustrates land subsidence contours in the San Joaquin River and Tulare Lake hydrologic regions from 1926 to 1970.

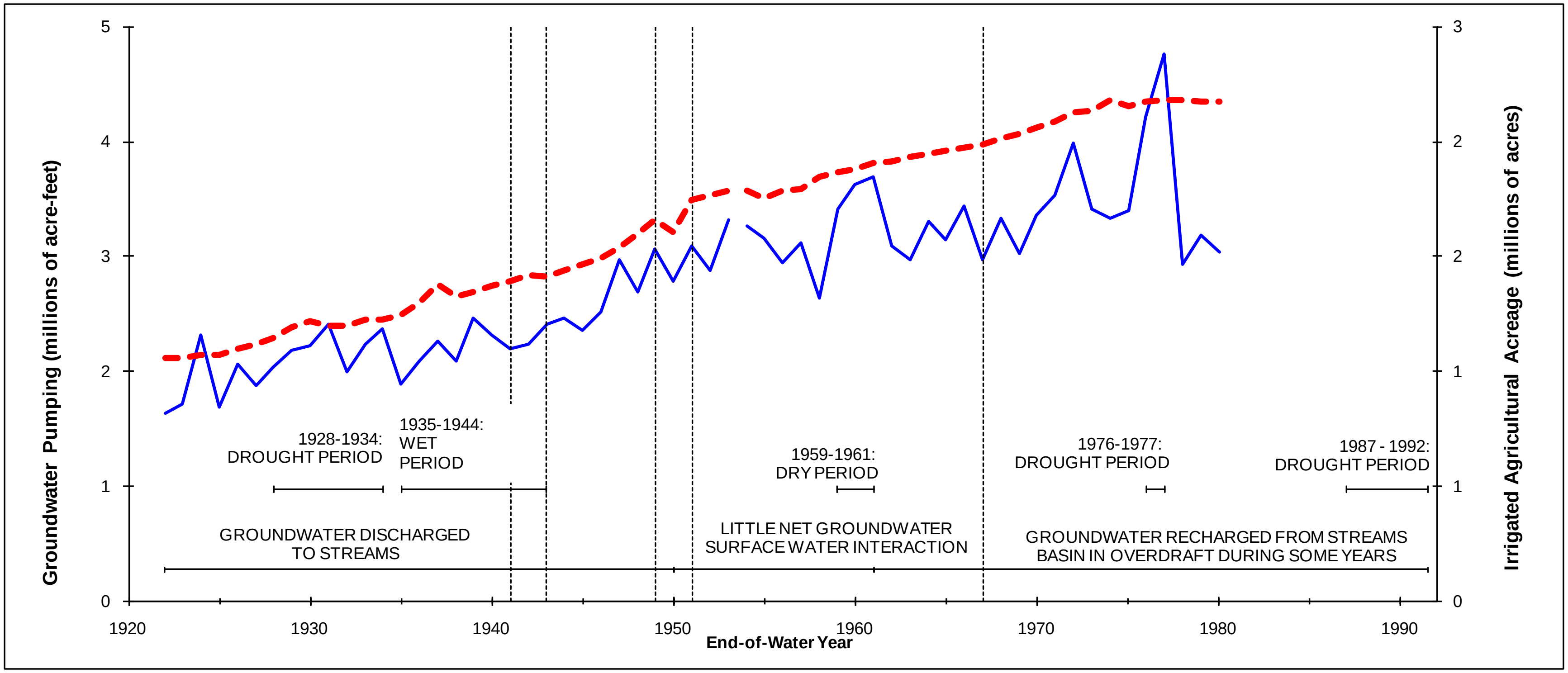
More recent subsidence rates in the Restoration Area range from about 0.15 foot per year to 0.75 foot per year, as calculated from survey data collected between December 2011 and December 2015 (Reclamation 2016).

Surface water deliveries from the State Water Project and other regional conveyance facilities in the 1970s and 1980s significantly reduced the demand for groundwater for agricultural water use. Although reduced groundwater pumping and imported surface water largely diminished the subsidence problem, subsidence continued in some areas but at a slower rate, due to the time lag involved in the redistribution of pressures in the confined aquifers (DWR 2014a).

Groundwater quality in the San Joaquin Valley Groundwater Basin is variable, but is suitable for most urban and agricultural uses with the exception of some localized areas in the San Joaquin River hydrologic region. The primary constituents of concern include salinity, nitrate, arsenic, total dissolved solids (TDS), boron, chloride, selenium, dibromochloro-propane, and radon. Additional details on groundwater quality are provided in the PEIS/R (SJRRP 2011, page 12-25 to 12-29).

Inadequate drainage and accumulating salts have been persistent problems for irrigated agriculture along the west side and in parts of the east side of the San Joaquin River Hydrologic Region for more than a century. The most extensive drainage problems exist on the west side of the San Joaquin River and Tulare Lake hydrologic regions. The drainage problem developed as a result of imported water from man-made infrastructure, naturally occurring saline soils, and distinctive geology that prevents natural drainage.

Soils on the west side of the San Joaquin River Hydrologic Region are derived from marine sediments are high in salts and trace elements. Irrigation of these soils has mobilized salts and trace elements and facilitated their movement into the shallow groundwater. Much of the irrigation has been with imported water, which has resulted in inadequate drainage, rising groundwater, and increasing soil salinity.



Source: SJRRP 2011

Note:

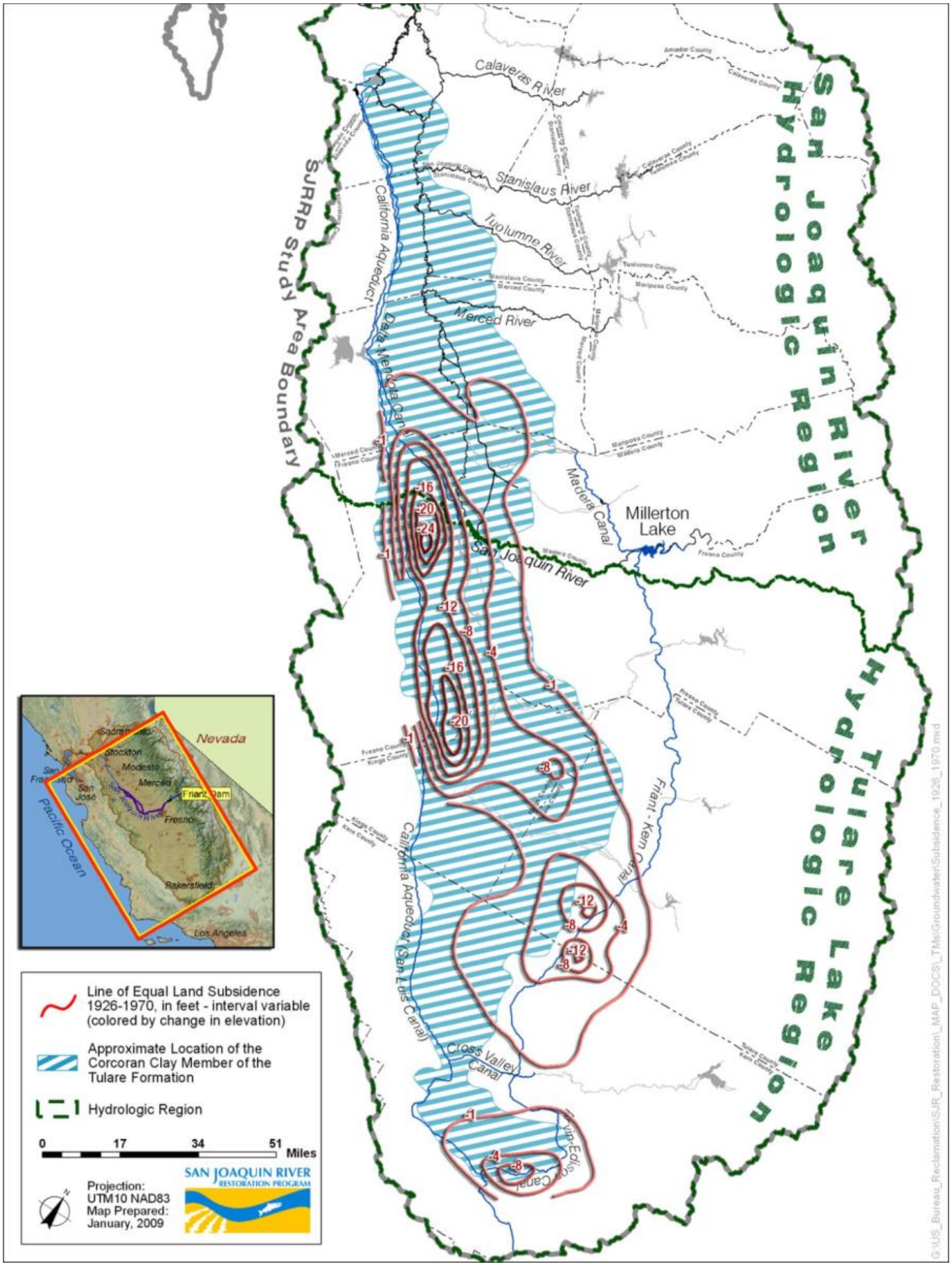
Data available for 1922 through 1980. Data developed as part of the Central Valley Ground-Surface Water Model.

Legend:

Irrigated agricultural acreage

Groundwater Pumping

Figure 13-3.
Historical Groundwater Pumping and Irrigated Agricultural Acreage for San Joaquin River Hydrologic Region



Source: SJRRP 2011

Figure 13-4.
Land Subsidence in the San Joaquin River and Tulare Lake Hydrologic Regions

In some portions of this hydrologic region, natural drainage conditions are poor, and imported irrigation water makes the upper, semiconfined aquifer (shallow groundwater table) even shallower. Therefore, groundwater levels often encroach on the root zone of agricultural crops, and subsurface drainage is often improved with constructed facilities (e.g., interceptor drains) in order to sustain irrigation.

Present problem areas were defined in the San Joaquin Valley Drainage Program (SJVDP) (DWR 2005) as locations where the water table is within 5 feet of the ground surface at any time during the year. Potential problem areas were defined in the SJVDP at locations where the water table is between 5 and 20 feet below the ground surface (DWR 2005). (The term “shallow groundwater” is referred to here as the highest zone of saturation down to a depth of approximately 20 feet below ground surface.)

Seepage and waterlogging of crops along the lower reaches of the San Joaquin River have historically been an issue. High periodic streamflows and local flooding combined with shallow groundwater near the San Joaquin River, and in the vicinity of its confluence with major tributaries, have resulted in seepage-induced waterlogging damage to low lying farmland. During flood-flow events, lateral seepage and structural stability issues with existing levees have been identified. Seepage problems were reported along the Chowchilla Bypass below the bifurcation structure on both sides of the channel in 2006.

Groundwater Resources of Tulare Lake Hydrologic Region

The Tulare Lake hydrologic region is a closed drainage basin at the south end of the San Joaquin Valley, south of the San Joaquin River watershed, encompassing surface water basins draining to the Kern Lake bed, Tulare Lake bed, and Buena Vista Lake bed. The primary aquifer in the San Joaquin Valley Groundwater Basin extends to as deep as 1,000 feet below ground surface in the southern portion of the basin (DWR 2003).

The semiconfined aquifer in the Tulare Lake hydrologic region contains the same hydrogeologic units as the San Joaquin River hydrologic region (Coast Range alluvium, Sierra Nevada sediments, and flood-basin deposits), but the region also contains Tulare Lake sediments in the axis of the valley (see Figure 13-2). The Corcoran Clay occurs at depths between 300 and 900 feet below ground surface in the Tulare Lake hydrologic region. The confined aquifer is overlain by the Corcoran Clay, but consists of the same hydrogeologic units as the unconfined to semiconfined aquifer. The Tulare Lake hydrologic region has semiconfined aquifer conditions to the west above the Corcoran Clay layer, and on the east side of the region where the clay is not present. Tulare Lake sediments present in the axis of the San Joaquin Valley have similar characteristics to flood-basin deposits present in the San Joaquin River hydrologic region (see Figure 13-2).

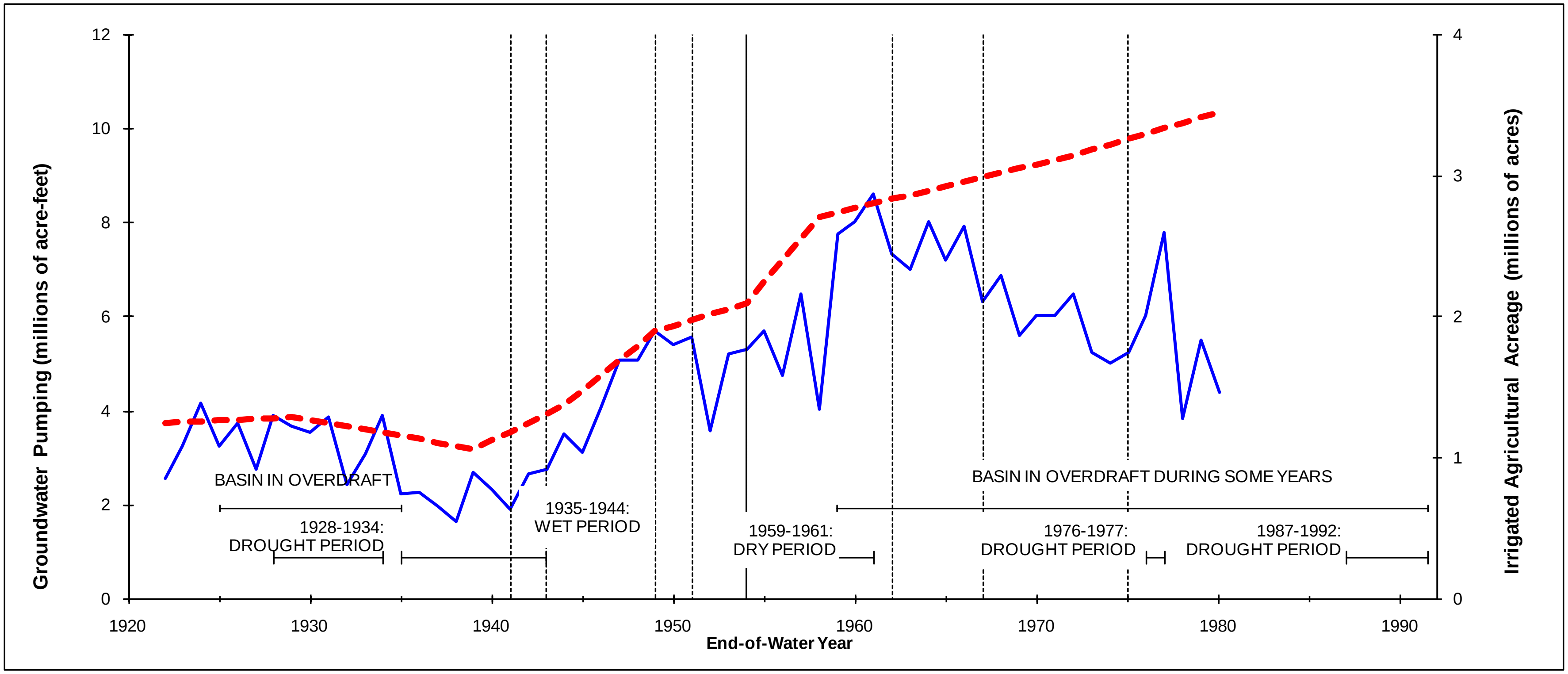
The semiconfined aquifer in the Tulare Lake hydrologic region is recharged by seepage from streams, canals, infiltration of applied water, and subsurface inflow. Precipitation is a source of recharge to the semiconfined aquifer only in wet years. Seepage from streams and canals is highly variable and depends on annual hydrologic conditions. Some of the water recharged to the semiconfined aquifer seeps through the confining clay layers, including the Corcoran Clay, which are discontinuous in some areas. Lateral flow from the semiconfined aquifer also recharges the lower confined aquifer.

The Tulare Lake hydrologic region has historically been heavily reliant on groundwater supplies. Agricultural development in the Tulare Lake hydrologic region began in the 1800s, and groundwater has been the primary source of irrigation water. Figure 13-5 illustrates changes in groundwater pumping and irrigated acreage for the Tulare Lake hydrologic region from 1922 to 1980. As described in the PEIS/R (SJRRP 2011, page 12-41), groundwater use in this hydrologic region has historically accounted for 33 percent of the total annual water supply and for 35 percent of all groundwater use in the State. Groundwater use in the hydrologic region represents approximately 10 percent of the State's total agricultural and urban water use.

Similar to the San Joaquin River hydrologic region, the Tulare Lake hydrologic region has been impacted by historical groundwater level decline and resulting land subsidence. Groundwater level decline in central Fresno County between the 1940s and 1980s has been substantial; decreasing approximately 50 to 100 feet (Williamson et al. 1989). Groundwater levels in the lower confined aquifer in the west side of the Tulare Lake hydrologic region declined as much as 400 feet from predevelopment to the 1960s (Williamson et al. 1989). Land subsidence, resulting from groundwater level decline and to a lesser extent from oil and gas withdrawal and near-surface hydrocompaction, is illustrated on Figure 13-4.

As with the San Joaquin River hydrologic region, groundwater quality in the Tulare Lake hydrologic region is variable, but in general, is suitable for most urban and agricultural uses (DWR 2003). The primary constituents of concern are salinity, nitrate, dibromochloropropane, arsenic, TDS, boron, selenium, and radon. Groundwater use for agricultural water supply is limited because of the high TDS concentrations above the Corcoran Clay in the western portion of Fresno and King Counties. Salinity and trace elements in some soil and shallow groundwater on the western side of the Tulare Lake Hydrologic Region are also of concern.

Subsurface drainage problems associated with the west side of the San Joaquin Valley Groundwater Basin extend from north to south in the Tulare Lake Hydrologic Region. The northern boundary of the Tulare Lake Hydrologic Region with the San Joaquin River Hydrologic Region is partially bounded by Reaches 1 and 2 of the San Joaquin River. Seepage problems identified in Reaches 1 and 2 influence local groundwater conditions in the Kings Subbasin in the Tulare Lake Hydrologic Region. (See the "Groundwater Resources of San Joaquin River Hydrologic Region" section above for additional discussion on seepage and waterlogging along the San Joaquin River.)



Source: SJRRP 2011

Note:

Data available from 1922 to 1980. Data developed as part of the Central Valley Ground-Surface Water Model (Reclamation et al, 1990 as cited in SJRRP 2011a)

Legend:

Groundwater Pumping

Irrigated agricultural acreage

Figure 13-5.
Historical Groundwater Pumping and Irrigated Agricultural Acreage for Tulare Lake Hydrologic Region

Conjunctive Use Programs

Conjunctive management or conjunctive use refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Water is stored in the groundwater basin that is planned to be used later by intentionally recharging the basin when excess water supply is available, for example, during years of above-average surface water supply or through the use of recycled water (DWR 2014b).

Various forms of conjunctive use are practiced throughout California. The form of conjunctive use ranges from incidental conjunctive use benefits to rigorous management programs implemented through detailed operating guidelines. For this discussion, conjunctive use is characterized as incidental conjunctive use, artificial recharge, or active substitution. These three types of conjunctive use can occur individually or may be used in conjunction with one another. Major conjunctive use programs currently in place are highlighted in DWR's *California Water Plan Update* (DWR 2014b) and some of these programs are discussed below; however, this is not a complete summary of all conjunctive use programs currently in operation or planned.

Incidental Conjunctive Use

Incidental conjunctive use occurs when an area relies on surface water when it is available and on groundwater when surface water is not available. Development of surface water storage and delivery projects by U.S. Department of the Interior, Bureau of Reclamation (Reclamation), DWR, and others has been an important factor in allowing water users to reduce groundwater pumping and build up groundwater storage for future use. Management techniques may be used to define the timing and location of surface water deliveries and groundwater pumping to maximize water supply reliability. However, groundwater pumping may increase in years of below-average precipitation and reduced availability of imported surface water supplies.

Artificial Recharge

Conjunctive use programs incorporating artificial recharge methods require a source of surface water (imported or reclaimed) that is not needed for immediate use. The surface water is placed directly into the ground by various means, including spreading ponds and injection. This water is then available for use in dry periods. This is a common practice in many areas of the State, especially in the San Joaquin River and Tulare Lake hydrologic regions.

Active Conjunctive Use Programs

Active conjunctive use programs in the San Joaquin Valley Groundwater Basin, as described in the PEIS/R (SJRRP 2011, page 12-52 to 12-57), include those listed below, the last of which is active in the Project area.

- Semitropic Water Storage District Groundwater Banking Program.
- Kern Water Bank Authority, Kern Water Bank.
- City of Fresno, Leaky Acres Water Recharge Facility.

- Farmington Groundwater Recharge Program.
- Madera Irrigation District Water Supply Enhancement Project.
- Mendota Pool, Ten-Year Exchange Agreements, Proposed Annual Water Exchange, California.

Additional Proposed Groundwater Banking Projects
Additional direct and in-lieu recharge groundwater banks have been proposed in the San Joaquin Valley by Friant Division long-term contractors and non-Friant Division contractors. These proposed projects are listed in the PEIS/R (SJRRP 2011, page 12-56 to 12-57).

13.1.2 Project Setting

Delta-Mendota Subbasin

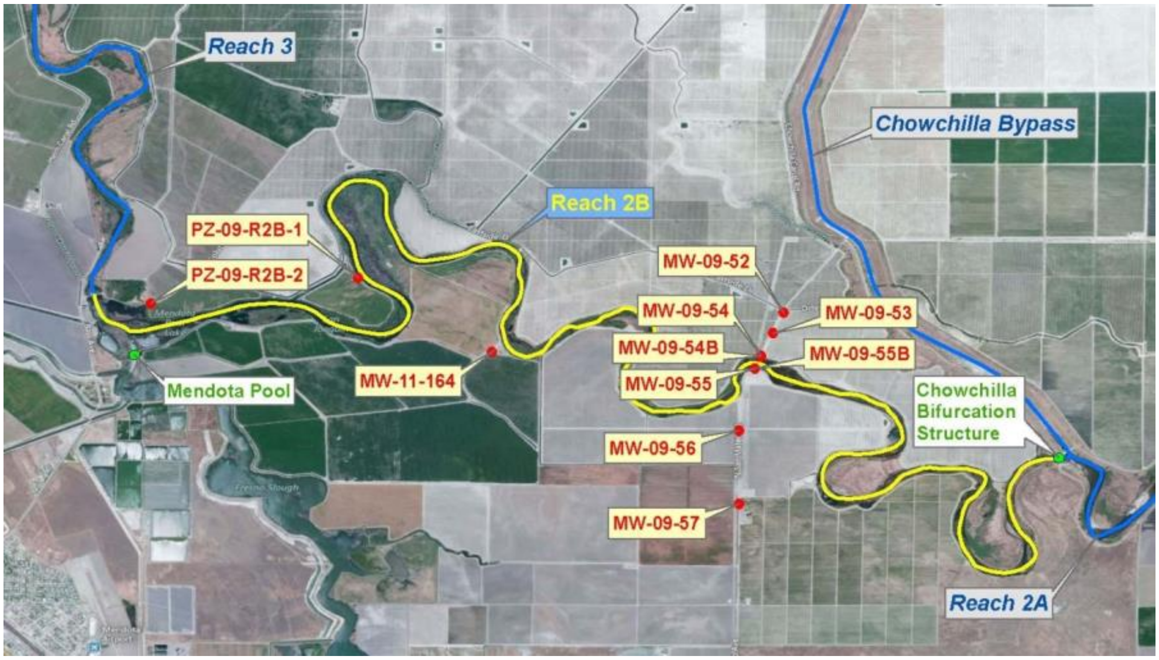
The San Joaquin Valley Groundwater Basin is composed of 16 subbasins: nine of these subbasins are located in the San Joaquin River hydrologic region and seven of these subbasins are located in the Tulare Lake hydrologic region (DWR 2006). The Project area is located within the Delta-Mendota subbasin, which is located within both the San Joaquin River hydrologic region and the Tulare Lake hydrologic region.

Groundwater in the Delta-Mendota subbasin occurs in three water-bearing zones within the Tulare Formation: terrace deposits, alluvium, and flood-basin deposits. The lower section of the Tulare Formation contains confined fresh water. The upper section of the Tulare Formation contains confined, semi-confined, and unconfined water. A shallow zone contains unconfined water approximately 25 feet or less below ground surface. The Corcoran Clay underlies the basin at depths that range from 100 to 500 feet below ground surface and acts as a confining layer.

Land subsidence has occurred in the Delta-Mendota subbasin due to historical groundwater level decline. Total subsidence near Mendota Pool reached nearly 9 feet by 2001, as compared to 1935 levels. Subsidence rates were greatest in the 1950s, with an average rate near Mendota Pool of 4.4 inches per year between 1953 and 1957. Subsidence rates near Mendota Pool were reduced in the 1990’s and 2000’s, with subsidence rates averaging 0.44 inches per year between 1997 and 2001 and 0.04 inches per year between 2003 and 2008 (Sneed et al. 2013). More recently, subsidence rates in the Project area ranged from about 0 to 3.6 inches per year, as calculated from survey data collected between December 2011 and December 2015 (Reclamation 2016). Subsidence rates vary annually, with higher rates occurring during critical dry conditions when the river is dry and when groundwater pumping is likely to increase. For example, average subsidence rates in the Project area were 0.15 to 0.3 foot per year in 2015 during critical dry conditions. Subsidence rates in Reach 2B are generally lower than rates found in Reach 4B and the Eastside Bypass due in part to continuous infiltration of surface water at Mendota Pool.

Groundwater Conditions in the Project Area

The Program has collected groundwater data at several locations in the Project area (see Figure 13-6). The majority of these wells monitor shallow groundwater located within the top 20 to 30 feet below ground surface. Station MW-09-54B has real-time data available online at the California Data Exchange Center. At this station, depth to groundwater has ranged from approximately 8 feet to 20 feet below ground surface from February 2010 to July 2013. In Reach 2B, shallower groundwater levels correspond to flood and Interim and Restoration flows, while deeper groundwater corresponds to summer and low flow periods.



Source: SJRRP 2012a

Figure 13-6.
Reach 2B Monitoring Well Atlas

Salt management is one of the most serious long-term groundwater quality issues in the San Joaquin Valley. In this respect, the groundwater in Reach 2B is of relatively high quality. Electrical conductivity, a measure of salinity, at Station MW-09-54B has for the same period ranged from approximately 75 to 325 microsiemens per centimeter (μS/cm). These values are well below the salinity threshold of 1,500 μS/cm established for Reach 2B, as described in the Program's *Seepage Management Plan* (SJRRP 2014). Groundwater quality data for other parameters are limited, as seen in Mathany et al. (2013).

13.2 Regulatory Setting

This section presents applicable Federal, State, and local laws and regulations associated with groundwater resources in the Project area.

13.2.1 Federal

This section presents applicable Federal regulations associated with groundwater resources in the Project area and vicinity.

Clean Water Act

Section 402 of the Clean Water Act created the National Pollutant Discharge Elimination System (NPDES) permit program. This program covers point sources of pollution discharging into a surface water body, including dewatering of shallow groundwater. See Chapter 14.0, "Hydrology – Surface Water Resources and Water Quality," for a discussion of the Clean Water Act.

13.2.2 State of California

This section describes State regulations and policies associated with groundwater resources in the Project area and vicinity.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act is California's statutory authority for protecting groundwater quality. See Chapter 14.0, "Hydrology – Surface Water Resources and Water Quality," for a discussion of Porter-Cologne Water Quality Control Act.

Assembly Bill 3030 – Groundwater Management Act

The Groundwater Management Act (Assembly Bill [AB] 3030) is found in sections 10750–10756 of the California Water Code and provides a systematic procedure for an existing local agency to develop a groundwater management plan. AB 3030 gives the local agency the authority to develop a groundwater management plan in groundwater basins defined in DWR Bulletin 118 (DWR 2003) and to raise revenue to pay for facilities to manage the basin (extraction, recharge, conveyance, quality). AB 3030 consists of 12 technical components, but others may be identified in the groundwater management plan. An AB 3030 plan can be developed after a public hearing, and adoption of a resolution of intention to adopt a groundwater management plan. Groundwater management plans have been developed for a number of irrigation districts, counties, cities, and other private districts in the San Joaquin Valley Groundwater Basin, including the San Joaquin River Exchange Contractors Water Authority's *AB 3030 – Groundwater Management Plan* (2008), which covers the Project area.

Other Existing Management Policies

Existing law regarding groundwater is controlled by jurisdictional decisions. The California Water Code provides limited authority over groundwater use by allowing the formation of special districts (or water agencies) through general or special legislation. As reported in the PEIS/R (SJRRP 2011, page 12-50), DWR identifies nine groundwater management agencies formed by such special legislation, none of which are located in the Central Valley area.

Another means of groundwater management exists for surface water agencies that can show that surface water delivered to a given area recharges a local aquifer. Several agencies have used this statutory authority granted by the legislature to levy charges for groundwater extraction. The only agency in the San Joaquin Valley that has exercised this authority is the Rosedale-Rio Bravo Water Storage District in the Tulare Lake hydrologic region, which does not serve the Project area.

13.2.3 Regional and Local

This section provides information about the regional and local regulatory setting, policies, and programs associated with groundwater resources in the Project area and vicinity.

Fresno County General Plan

The Fresno County General Plan Policy Document (Fresno County 2000) outlines several policies for groundwater resources. These policies include the following.

- Policies OS-A.12 through OS-A.17 encourage groundwater recharge, water banking, local groundwater management, and aquifer recharge.
- Policy OSA.25 seeks to protect groundwater resources from contamination and overdraft.
- Policy PF-C.21 provides for new wells that are in close proximity to live streams or water courses.

Madera County General Plan

The Madera County General Plan Policy Document (Madera County 1995) outlines several policies designed to protect groundwater resources. For example, Policies 5.C.1 and 5.C.7 seeks to protect areas of groundwater recharge and to protect groundwater resources from contamination and further overdraft.

13.3 Environmental Consequences and Mitigation Measures

13.3.1 Impact Assessment Methodology

This section describes the impact assessment methodology used to evaluate potential impacts on groundwater resources. The analysis of the Project alternatives is both qualitative and quantitative in nature. Construction-related effects on groundwater were evaluated qualitatively based on review of regional groundwater information and the type of construction activities anticipated. The assessment of areas potentially affected by seepage was quantitative in nature and was based upon a cross-sectional seepage model developed for the Project area by the Program.

The quantitative approach was used to develop estimates of areas vulnerable to seepage and high water table effects associated with potential rises in groundwater levels in the Project area due to the implementation of Project alternatives. The aquifer response to a flow of 4,500 cubic feet per second (cfs) in the San Joaquin River was used to evaluate potential rise in groundwater elevations in the absence of seepage control measures. Results from this modeling represent “worst case” conditions because all Project alternatives would implement seepage control measures as part of the Project design.

The U.S. Geological Survey (USGS) Central Valley Hydrologic Model (CVHM), a valley-wide numerical groundwater flow model (USGS 2009), was used as a starting point for the cross-sectional seepage model. Specifically, CVHM was used as the basis for the development of a series of six, simplified cross-sectional seepage model profiles located at various distances along Reach 2B (Figure 13-7). The CVHM was not directly used because the aerial and vertical grid spacing is too coarse to evaluate groundwater levels immediately adjacent to the river (CVHM was constructed with a lateral grid size of 1 mile by 1 mile and a top layer thickness of 50 feet).

USGS is currently updating CVHM to include the results of a Hydrologic Engineering Center River Analysis System (HEC-RAS) model for the Project area as well as refined grid spacing and layering for the purposes of assessing SJRRP groundwater impacts. These revisions to the CVHM were not available at the time the Draft Environmental Impact Statement/Report (EIS/R) was prepared (Traum et al. 2014).

Each of the six groundwater model profiles shown in Figure 13-7 is oriented perpendicular to the river channel, and extends approximately 3 miles in each direction away from the river. The profile locations were selected away from river meanders, if possible, in order to minimize numerical errors. Each profile model is composed of six layers, extending from the ground or river surface to the top of the regional confining aquifer unit, the Corcoran Clay. The lateral grid cell size at the river is 10 feet and gradually increases away from the river to a maximum of 400 feet.

The output from the existing HEC-RAS model was used to assign water levels in the river channel at each cross sectional profile. High resolution LiDAR (Light Detection and Ranging) data were incorporated into the model to account for variations in land surface topography. The depths to water simulated by the model[1] were compared with the significance criteria, described below. The distance from the levees at which simulated water level rises exceed the significance criteria were imported into a Geographic Information System (GIS) platform and interpolated spatially along the course of the river to estimate the acreage of land potentially impacted by rising groundwater as a result of Restoration Flows.

[1] The scenarios simulated by the cross sectional model were based on the initial alternatives evaluation (Project Description Technical Memorandum, Appendix A, SJRRP 2012b). The model scenarios that are comparable to the current alternatives are FP2, which simulates a narrow floodplain, and FP4, which simulates a wide floodplain.

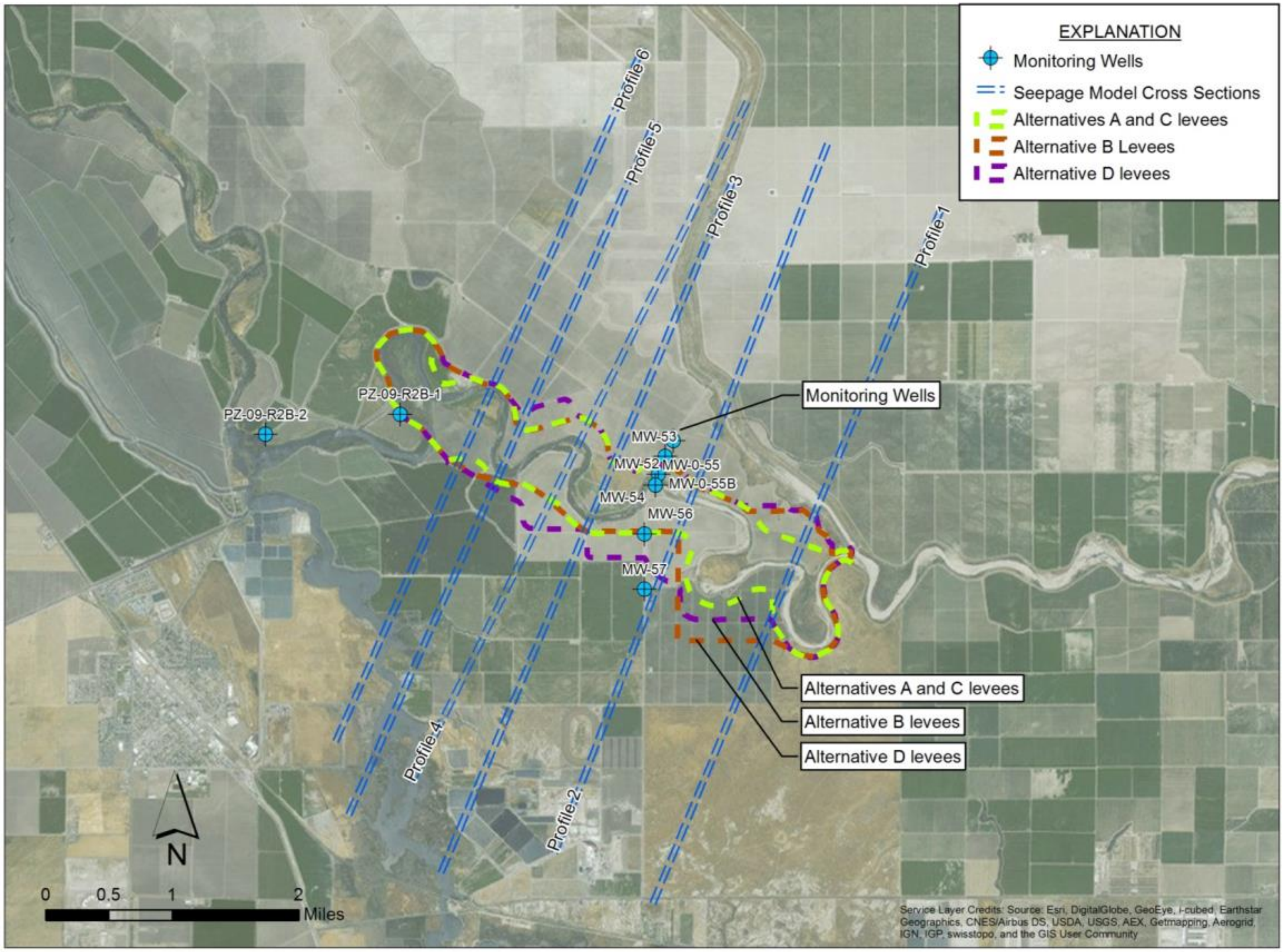


Figure 13-7.
Location of Cross Sectional Seepage Model Cross-Sections

13.3.2 Significance Criteria

The thresholds of significance for groundwater impacts are based on the Environmental Checklist Form in Appendix G of the California Environmental Quality Act (CEQA) Guidelines, as amended. These thresholds also encompass factors taken into account under the National Environmental Policy Act (NEPA) to determine the significance of an action in terms of its context and the intensity of its effects. Impacts on groundwater resources would be significant if implementation of an Alternative would cause the following:

- A change in groundwater level resulting in long-term overdraft conditions for the groundwater basins.
- A change in groundwater level adjacent to the San Joaquin River resulting in increased groundwater levels in localized areas already experiencing high groundwater levels.
- A change in groundwater quality resulting in substantially adverse effects to designated beneficial uses of groundwater.

13.3.3 Impacts and Mitigation Measures

This section provides an evaluation of direct and indirect effects of the Project Alternatives on groundwater. It includes analyses of potential effects relative to No-Action conditions in accordance with NEPA and potential impacts compared to existing conditions to meet CEQA requirements. The analysis is organized by Project alternative with specific impact topics numbered sequentially under each alternative. With respect to groundwater, the environmental impact issues and concerns are:

1. Temporary Construction-Related Effects on Groundwater Quality.
2. Long-term Changes in Groundwater Quality.
3. Changes in Groundwater Levels.
4. Changes in Groundwater Recharge.

Other groundwater-related issues covered in the PEIS/R are not covered here because they are programmatic in nature and/or are not relevant to the Project area. Long-term overdraft as a result of Restoration Flows is also not anticipated due to the additional infiltration of river water to the regional aquifer system. Therefore, these issues are not applicable and are not discussed further.

No-Action Alternative

Under the No-Action Alternative, the Project would not be implemented and none of the Project features would be developed in Reach 2B of the San Joaquin River. However, other proposed actions under the SJRRP would be implemented, including habitat restoration in other reaches, augmentation of river flows, and reintroduction of salmon. Without the Project in Reach 2B, however, the proposed actions in other reaches would not achieve the Settlement goals. This section describes the impacts of the No-Action Alternative. The analysis is a comparison to existing conditions.

Impact GRW-1 (No-Action Alternative): ***Temporary Construction-Related Effects on Groundwater Quality.*** Under the No-Action Alternative, the Project would not be implemented and there would be no construction activities in the Project area. As a result, there would be **no impact** to groundwater quality from construction-related effects.

Impact GRW-2 (No-Action Alternative): ***Long-term Changes in Groundwater Quality.*** Under the No-Action Alternative, the quality of shallow groundwater is not anticipated to change substantially. Groundwater quality in the reach is influenced by the quality of the surface water that infiltrates locally. Because Millerton Lake is a source of high quality water with lower salinity than Mendota Pool, infiltration of Restoration Flows would improve the quality of shallow groundwater in the reach. Compared to existing conditions, there would be a **beneficial** effect on groundwater quality over time.

Impact GRW-3 (No-Action Alternative): ***Changes in Groundwater Levels.*** Prior to the start of Interim Flows in October 2009, portions of the Project area historically experienced groundwater seepage to adjacent lands during elevated flood flows. Seepage in Reach 2B has been observed at flows above 1,300 cfs when the Mendota Dam flashboards are in place (RMC 2007). Seepage in Reach 2B caused by high flows can be reduced by removal of the flashboards and by opening the sluice gates at Mendota Dam in advance of high-flow conditions. This process lowers the water level in the pool during high flow events to reduce seepage impacts to adjacent lands.

Under the No-Action Alternative, flows could continue to affect areas outside of the levees that have historically experienced groundwater seepage. Increases in flow duration or frequency could affect adjacent agricultural lands by saturating soil in the rooting zone, impairing plant growth and survival, or interfering with the ability to use machinery to work soil. However, Program-level seepage management measures would be implemented in the Project area that would minimize impacts to areas near the river channel. Consequently, adverse effects to agricultural lands would be minimized. Compared to existing conditions, seepage-related impacts in the Project area would continue under the No-Action Alternative; however, Program-level seepage management measures would be implemented to minimize seepage-related effects. As a result, there would be a **less-than-significant** impact from changes in groundwater levels.

Impact GRW-4 (No-Action Alternative): ***Changes in Groundwater Recharge.*** Under the No-Action Alternative, Restoration Flows would be conveyed through Reach 2B. The No-Action Alternative would maintain the existing levee alignments and heights and maximum conveyance would continue to be limited to the existing channel capacity. Although the area for potential groundwater recharge would not change compared to existing conditions, flow would occur year-round for most water year types (see Figure 1-10) resulting in groundwater recharge in previously dry sections of the river (i.e., the river channel above the San Joaquin River arm of Mendota Pool). As a result, there would be a **beneficial** effect on groundwater recharge in the Project area.

Alternative A (Compact Bypass with Narrow Floodplain and South Canal)

Alternative A would include construction of Project facilities including a Compact Bypass channel, a new levee system encompassing the river channel with a narrow floodplain, and the South Canal. The Reach 2B floodplain would have an average width of approximately 3,000 feet. Other key features include construction of the Mendota Pool Dike (separating the San Joaquin River and Mendota Pool), a fish barrier below Mendota Dam, and the South Canal bifurcation structure with fish passage facility and fish screen, modification of the San Mateo Avenue crossing, and the removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure. Construction activity is expected to occur intermittently over an approximate 132-month timeframe.

Impact GRW-1 (Alternative A): ***Temporary Construction-Related Effects on Groundwater Quality.*** Construction associated with channel and structural improvements under Alternative A could temporarily influence surface water quality, and could potentially lead to changes in groundwater quality. Compared to the No-Action Alternative, construction activities under Alternative A could discharge waste petroleum products or other construction-related substances that could enter waterways in runoff. In addition, chemicals associated with operating heavy machinery would be used, transported, and stored onsite during construction activities. These substances could be inadvertently introduced into the San Joaquin River through site runoff or onsite spills. Sediment and chemicals could degrade water quality in the San Joaquin River. This would potentially affect groundwater quality through percolation from the soil surface or surface water interaction with underlying groundwater. Furthermore, the Project could potentially impact groundwater quality through discharges of dewatering effluent if groundwater is encountered during construction.

When comparing Alternative A to existing conditions, impacts to groundwater quality from potential discharges of chemicals through site runoff or onsite spills would be similar to those described above (i.e., the comparison of Alternative A to the No-Action Alternative). These impacts to groundwater quality would be **potentially significant**.

Mitigation Measure GRW-1A (Alternative A): ***Prepare and Implement a Stormwater Pollution Prevention Plan.*** This mitigation measure is the same as Mitigation Measure SWQ-1 (Alternative A), as described in Chapter 14.0, “Hydrology – Surface Water Quality.” Construction activities are subject to construction-related stormwater permit requirements of the Federal Clean Water Act’s NPDES program. A Stormwater Pollution Prevention Plan (SWPPP) will be prepared that identifies best management practices (BMPs) to prevent or minimize the introduction of contaminants into surface waters. The SWPPP will detail the construction-phase housekeeping measures for control of contaminants, as well as the treatment measures and BMPs to be implemented for control of pollutants once the Project has been constructed. The SWPPP will establish good housekeeping measures such as construction vehicle storage and maintenance, handling procedures for hazardous materials, and waste management best management practices. They include procedural and structural measures to prevent release of wastes and materials used at the site. Implementation of the SWPPP would avoid or reduce runoff pollutants at the construction sites to the “maximum extent practicable.”

> **Implementation Action**: The Project proponents and/or construction contractor will prepare and implement an SWPPP consistent with requirements in the Statewide NPDES Construction General Permit. The SWPPP will set forth a best

management practice monitoring, maintenance, and reporting schedule and will identify the responsible entities during the construction and post-construction phases. Monitoring will include visual inspections of the best management practices, inspection for non-stormwater discharges, and visual inspection and/or sample collection of stormwater discharges. If monitoring results indicate polluted discharges, a construction site and run-on evaluation will be conducted to determine the source of the pollutant and corrective actions will be implemented immediately if necessary.

Location: Project areas with active construction or used by construction personnel, including access roads, staging and storage areas, borrow sites, within the river channel and on adjacent uplands.

Effectiveness Criteria: Performance tracking will be based on successful compliance with the Statewide NPDES Construction General Permit.

Responsible Agency: Reclamation and the construction contractor.

Monitoring/Reporting Action: At a minimum, annual reports will be submitted to the State Water Resources Control Board via the Storm Water Multiple Application and Report Tracking System.

Timing: The SWPPP will be developed prior to construction and will be implemented during construction.

Mitigation Measure GRW-1B (Alternative A): *Prepare and Implement a Construction Groundwater Management Plan.* The Project proponents and/or construction contractor will prepare and implement a Construction Groundwater Management Plan that includes a protocol for sampling and analyzing the quality of dewatering effluent during construction for comparison with existing groundwater. This plan will be consistent with the monitoring and reporting program required by the Statewide NPDES Construction General Permit and/or RWQCB's NPDES Permit for *Dewatering and Other Low Threat Discharges to Surface Waters,* Order No. R5-2013-0074 (General Permit for Low Threat Discharges).[2]

Implementation Action: The Project proponents and/or construction contractor will prepare and implement a Construction Groundwater Management Plan. The plan will include a protocol for sampling and analysis of dewatering effluent during construction and include a description of the sampling methods, locations, and frequency, the constituents monitored, and how the receiving waters will be visually inspected. If monitoring results indicate polluted effluent, a Report of Waste Discharge will be filed with the RWQCB to initiate consultations to obtain a Waste Discharge Order specifying approved treatment methods and disposal options.

Location: Project areas with active dewatering.

[2] The General Permit for Low Threat Discharges covers construction dewatering when the discharges do not contain significant quantities of pollutants and they are either 4 months or less in duration or have a daily average discharge flow that does not exceed 0.25 million gallons per day.

Effectiveness Criteria: Performance tracking of this mitigation measure will be based upon successful compliance with the Statewide NPDES Construction General Permit and/or General Permit for Low Threat Discharges.

Responsible Agency: Reclamation and the construction contractor.

Monitoring/Reporting Action: At a minimum, annual reports will be submitted to Reclamation managers summarizing the monitoring data obtained during the previous year(s).

Timing: The Construction Groundwater Management Plan will be developed prior to construction and will be implemented during construction.

Impacts to groundwater quality would be **less than significant** after mitigation.

Impact GRW-2 (Alternative A): ***Long-term Changes in Groundwater Quality.*** Compared to the No-Action Alternative, implementation of Alternative A would construct new levees set back from the San Joaquin River, expand the floodplain, and increase the conveyance capacity of the reach. Groundwater in the reach is influenced by soil quality and surface water that infiltrates locally. Conversion of previously irrigated agricultural lands into floodplain areas would reduce new sources of nutrients and pesticides that could influence groundwater quality locally.

Alternative A also includes passive riparian habitat restoration and compatible agricultural practices in the floodplain (e.g., annual crops, pasture, or floodplain-compatible permanent crops). Similar to No-Action conditions, where irrigation of agricultural lands would influence the quality of the shallow aquifer, floodplain inundation of agricultural areas would facilitate movement of nutrients and other materials into the shallow aquifer. However, unlike No-Action conditions, nutrient cycling and pollutant uptake following high flow events on the floodplain would be supported by native aquatic, riparian, and floodplain vegetation.

Compared to existing conditions, surface water quality in Reach 2B would primarily be influenced by San Joaquin River flows (instead of other inflows to Mendota Pool) under Alternative A. Because Millerton Lake is a source of high quality water with lower salinity than Mendota Pool, infiltration of river flows could improve the quality of shallow groundwater in Reach 2B. This would be a **beneficial** effect to long-term groundwater quality.

Impact GRW-3 (Alternative A): ***Changes in Groundwater Levels.*** Restoration Flows could cause changes to groundwater levels in Reach 2B in areas adjacent to the San Joaquin River. Drainage problem areas were defined in the SJVDP (DWR 2005) as locations where the water table is within 5 feet of the ground surface. Potential impacts from the Project have been evaluated in relation to similar thresholds: acres of land outside the proposed levee alignments anticipated to have shallow groundwater elevations above 5 and 7 feet below ground surface. These thresholds represent a range of depths where waterlogging of crops and root-zone salinization may affect adjacent land uses. As described in Section 13.3.1, groundwater levels associated with the conveyance capacity of the reach (4,500 cfs) have been simulated and the acreage of land above these thresholds have been quantified in GIS.

Modeling results indicate the potential presence of shallow groundwater levels above the thresholds of 5 and 7 feet below ground surface along the edges of the San Joaquin River levees in the absence of seepage control measures. Based on the model results, the area outside of the levee alignments with simulated depth to groundwater less than 5 feet is 320 acres and an additional 60 acres is simulated to have depth to groundwater between 5 and 7 feet when river flows are at 4,500 cfs. Figure 13-8 shows the potential areas with depths to groundwater less than monitoring thresholds for the narrow floodplain alternatives, which includes Alternative A. The model shows that infiltration and seepage from the river migrates primarily downward to the water table. The mound of groundwater produced from this infiltration and seepage does not extend more than 1,000 feet laterally from the river.

Under Alternative A, newly constructed levees would be set back from the San Joaquin River such that the Reach 2B floodplain would have an average width of approximately 3,000 feet. Although shallow groundwater could potentially be present and effect adjacent land uses, levee design includes implementation of seepage control measures.

Seepage of river water through or under levees is a concern for levee integrity and adjacent land uses. Through-seepage, water that seeps laterally through the levee section, would be addressed through proper levee design and construction (e.g., selection of low porosity materials and proper compaction). Under-seepage, water that seeps laterally by travelling under the levee section, is primarily controlled by the native soils beneath the levee and seepage control measures would be included where native soils do not provide sufficient control. Seepage control measures would be included, as part of the Project, in in areas where under-seepage is likely to affect adjacent land uses. Seepage control measures could include slurry walls, interceptor drains, seepage wells, seepage berms, land acquisition (fee title or seepage easements) and other measures that can be implemented within the Project area (see Section 2.2.4).

In addition to Project design features, seepage management would be implemented during Project operations. Areas of high groundwater would be identified in accordance with the Program's *Seepage Management Plan* (SJRRP 2014). Once identified, the Program's *Seepage Management Plan* would be implemented to identify measures that would be taken to reduce potential impacts. Through these actions, potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be further avoided or substantially reduced. Seepage impacts to adjacent lands (outside of the floodplain proposed under Alternative A) are likely to be similar to or less than seepage impacts to adjacent lands (outside of the existing levee alignment) under the No-Action Alternative.

Compared to existing conditions, groundwater levels would likely increase in areas outside of the floodplain proposed under Alternative A, however, seepage impacts would be avoided or substantially reduced by implementation of Project design features and seepage management measures. Therefore, impacts would be **less than significant**.

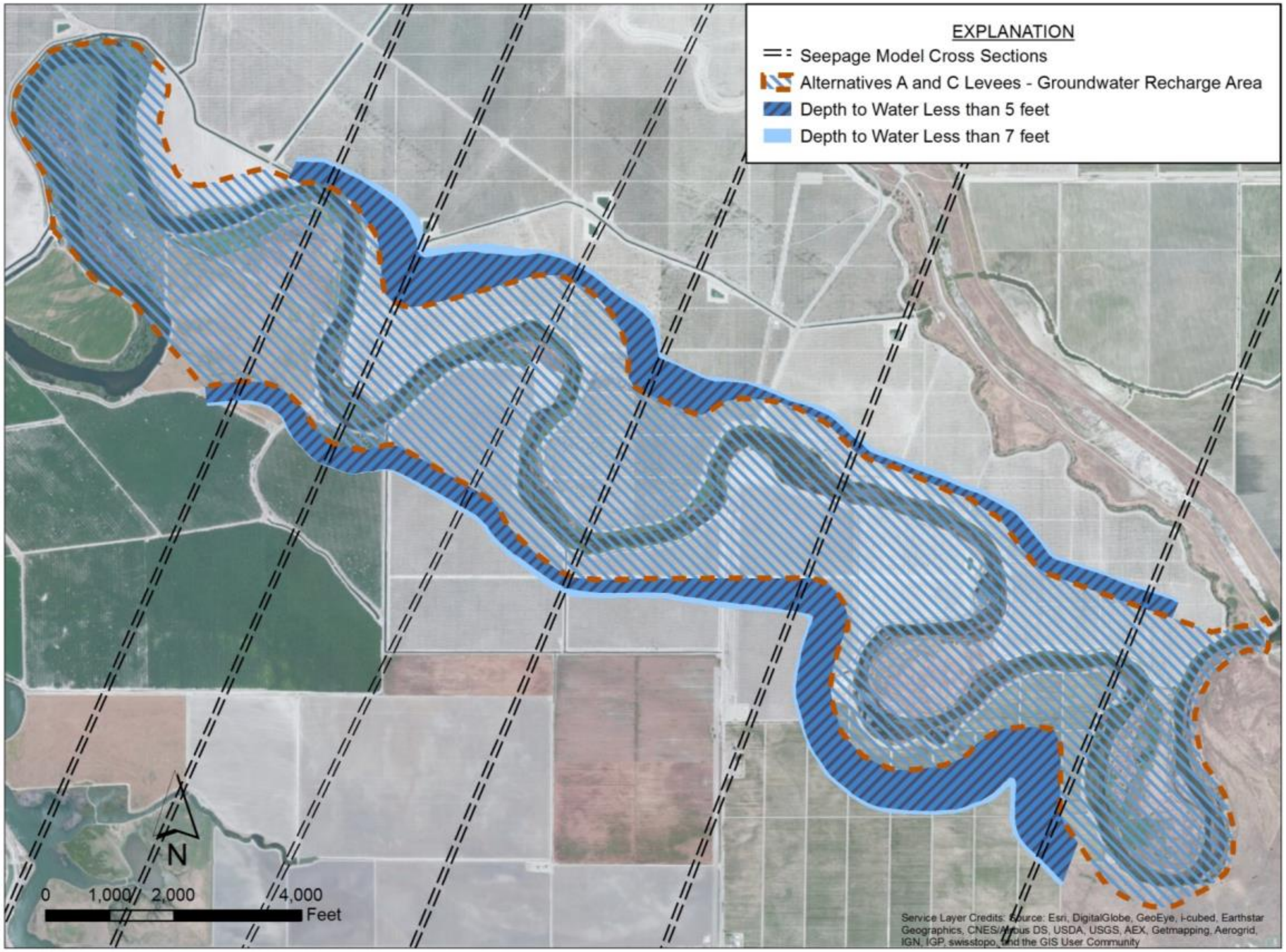


Figure 13-8.
Potential Areas with Depths to Groundwater Less than Monitoring Thresholds – Alternatives A and C

Impact GRW-4 (Alternative A): ***Changes in Groundwater Recharge.*** Compared to the No-Action Alternative, Action Alternatives would construct new levees set back from the San Joaquin River, expand the floodplain, and increase the conveyance capacity of the reach to 4,500 cfs. Under Alternative A the floodplain would have an average width of approximately 3,000 feet. Flow would be conveyed though Reach 2B in the river channel and floodplain providing opportunities for groundwater recharge. Floodplain and channel grading would be used to increase inundation areas during high flow events, remove high areas where flow connectivity would be impeded, and to create floodplain benches adjacent to the river channel to increase the frequency of inundation (see Section 2.2.4). Increasing inundation areas and inundation frequencies would facilitate groundwater recharge in the reach.

Compared to existing conditions, flow would also occur year-round for most water year types (see Figure 1-10) resulting in groundwater recharge in previously dry sections of the river (i.e., in the river channel above the San Joaquin River arm of Mendota Pool). As a result, there would be a **beneficial** effect on groundwater recharge in the Project area.

Alternative B (Compact Bypass with Consensus-Based Floodplain and Bifurcation Structure), the Preferred Alternative

Alternative B would include construction of Project features including a Compact Bypass channel, a new levee system with a wide, consensus-based floodplain encompassing the river channel, the Mendota Pool Control Structure, and the Compact Bypass Control Structure with fish passage facility and fish screen. Other key features include construction of a fish passage facility at the San Joaquin River control structure at the Chowchilla Bifurcation Structure, the re-route of Drive 10 ½ (across the Compact Bypass control structure), and removal of San Mateo Avenue crossing. Construction activity is expected to occur intermittently over an approximate 157-month timeframe. The Reach 2B floodplain would have an average width of approximately 4,200 feet.

Impact GRW-1 (Alternative B): ***Temporary Construction-Related Effects on Groundwater Quality.*** Construction associated with channel and structural improvements under Alternative B could temporary influence water quality, and could potentially lead to changes in groundwater quality. Refer to Impact GRW-1 (Alternative A). Potential impacts of Alternative B would be the same as potential impacts of Alternative A. These impacts would be **potentially significant**.

Mitigation Measures GRW-1A and GRW-1B (Alternative B): ***Prepare and Implement a Stormwater Pollution Prevention Plan, Prepare and Implement a Construction Groundwater Management Plan.*** Refer to Mitigation Measures GRW-1A and GRW-1B (Alternative A). The same measures would be used here. Impacts would be **less than significant** after mitigation.

Impact GRW-2 (Alternative B): ***Long-term Changes in Groundwater Quality.*** Refer to Impact GRW-2 (Alternative A). Potential effects of Alternative B would be the same as potential effects of Alternative A. Conversion of previously irrigated agricultural lands into floodplain areas would reduce new sources of nutrients and pesticides that could influence groundwater quality locally. These effects would be **beneficial**.

Impact GRW-3 (Alternative B): *Changes in Groundwater Levels.* Modeling results indicate the potential presence of shallow groundwater levels above the thresholds of 5- and 7-feet below ground surface along the edges of the San Joaquin River. Based on the model results, the area outside of the levee alignments with simulated depth to water less than 5 feet is 360 acres and an additional 80 acres have simulated depth of 5 to 7 feet below ground surface. Figure 13-9 shows the potential areas with depths to groundwater less than monitoring thresholds for the wide floodplain alternatives, including Alternative B. Similar to Alternative A, the model shows that infiltration and seepage from the river migrates primarily downward to the water table. The mound of groundwater produced from this infiltration and seepage does not extend more than 1,000 feet laterally from the river.

Through levee design features and seepage management measures, as described in Impact GRW-2 (Alternative A), potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced in Alternative B. Compared to the No-Action Alternative, seepage impacts to adjacent lands under Alternative B are likely to be similar to or less than seepage impacts to adjacent lands under the No-Action Alternative.

Compared to existing conditions, groundwater levels would likely increase in areas immediately adjacent to San Joaquin River levees, however, seepage impacts would be avoided or substantially reduced by implementation of Project design features and seepage management measures. Therefore, these impacts would be **less than significant**.

Impact GRW-4 (Alternative B): *Changes in Groundwater Recharge.* Refer to Impact GRW-4 (Alternative A). Potential effects of Alternative B would be similar to potential effects of Alternative A, with the exception that the floodplain would have an average width of approximately 4,200 feet. Increasing inundation areas and inundation frequencies would facilitate groundwater infiltration causing a **beneficial** effect on groundwater recharge.

Alternative C (Fresno Slough Dam with Narrow Floodplain and Short Canal)

Alternative C would include construction of Project features including Fresno Slough Dam, a new levee system with a narrow floodplain encompassing the river channel, and the Short Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the Short Canal control structure and fish screen, the Chowchilla Bifurcation Structure fish passage facility, modification of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 133-month timeframe. The Reach 2B floodplain would have an average width of approximately 3,000 feet.

Impact GRW-1 (Alternative C): *Temporary Construction-Related Effects on Groundwater Quality.* Construction associated with channel and structural improvements under Alternative C could temporary influence water quality, and could potentially lead to changes in groundwater quality. Refer to GRW-1 (Alternative A). Potential impacts of Alternative C would be the same as potential impacts of Alternative A. These impacts would be **potentially significant**.

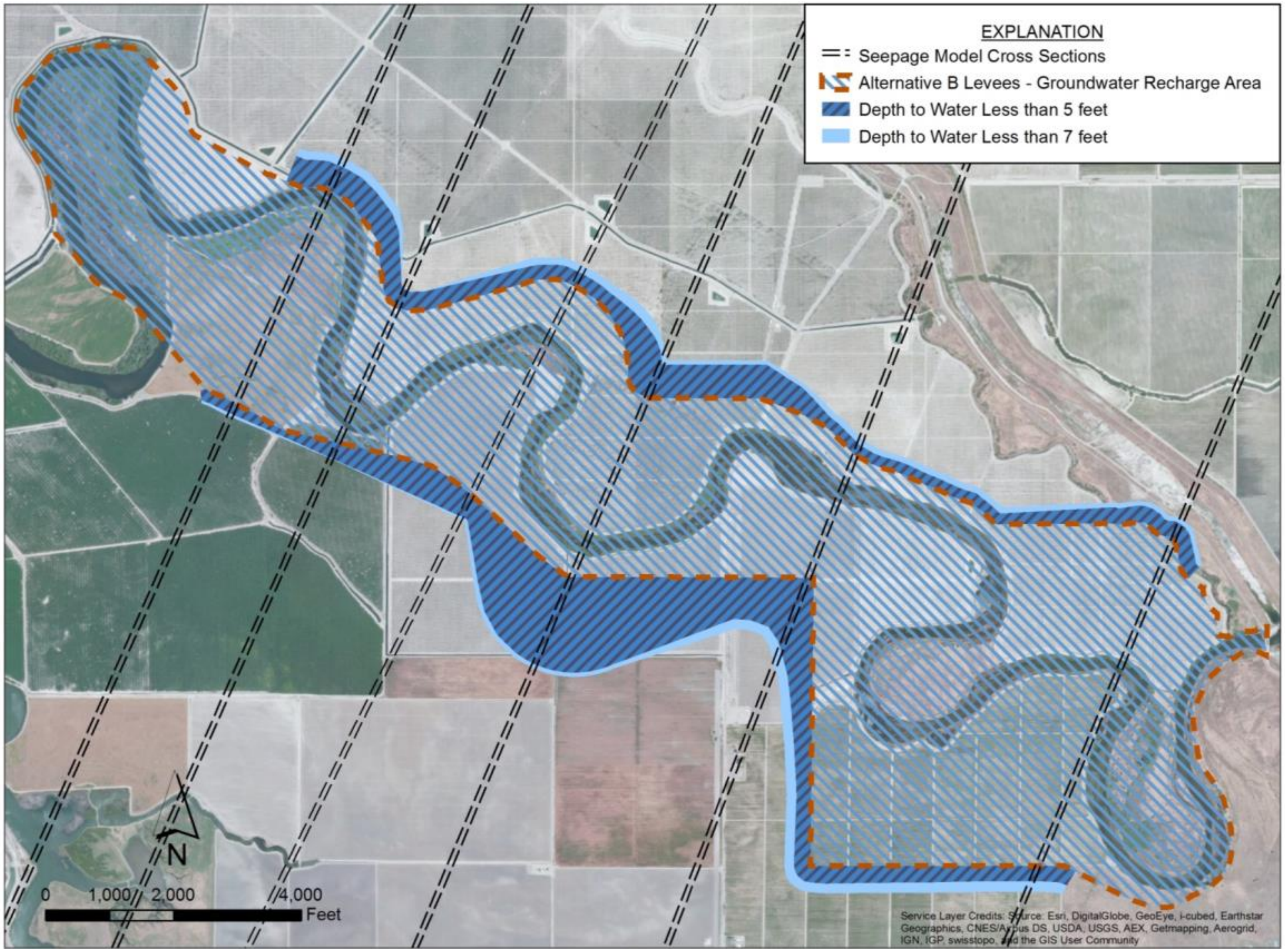


Figure 13-9.
Potential Areas with Depths to Groundwater Less than Monitoring Thresholds – Alternative B

Mitigation Measures GRW-1A and GRW-1B (Alternative C): ***Prepare and Implement a Stormwater Pollution Prevention Plan, Prepare and Implement a Construction Groundwater Management Plan.*** Refer to Mitigation Measures GRW-1A and GRW-1B (Alternative A). The same measures would be used here. Impacts would be **less than significant** after mitigation.

Impact GRW-2 (Alternative C): ***Long-term Changes in Groundwater Quality.*** Refer to Impact GRW-2 (Alternative A). Potential effects of Alternative C would be the same as potential effects of Alternative A, with the exception that agricultural practices would not occur on the floodplain. Conversion of previously irrigated agricultural lands into floodplain areas would reduce new sources of nutrients and pesticides that could influence groundwater quality locally. These effects would be **beneficial**.

Impact GRW-3 (Alternative C): ***Changes in Groundwater Levels.*** Refer to Impact GRW-3 (Alternative A). The impacts to groundwater levels for Alternative C would be the same as for Alternative A because both alternatives involve a narrow floodplain. These impacts would be **less than significant**.

Impact GRW-4 (Alternative C): ***Changes in Groundwater Recharge.*** Refer to Impact GRW-4 (Alternative A). Potential effects of Alternative C would be the same as potential effects of Alternative A. Increasing inundation areas and inundation frequencies would facilitate groundwater infiltration causing a **beneficial** effect on groundwater recharge.

Alternative D (Fresno Slough Dam with Wide Floodplain and North Canal)

Alternative D would include construction of Project features including Fresno Slough Dam, a new levee system with a wide floodplain encompassing the river channel, and the North Canal. Other key features include construction of the Mendota Dam fish passage facility, the Fresno Slough fish barrier, the North Canal bifurcation structure with fish passage facility and fish screen, removal of the San Joaquin River control structure at the Chowchilla Bifurcation Structure, removal of San Mateo Avenue crossing, and Main Canal and Helm Ditch relocations. Construction activity is expected to occur intermittently over an approximate 158-month timeframe. The Reach 2B floodplain would have an average width of approximately 4,200 feet.

Impact GRW-1 (Alternative D): ***Temporary Construction-Related Effects on Groundwater Quality.*** Construction associated with channel and structural improvements under Alternative D could temporary influence water quality, and could potentially lead to changes in groundwater quality. Refer to Impact GRW-1 (Alternative A). Potential impacts of Alternative D would be the same as potential impacts of Alternative A. These impacts would be **potentially significant**.

Mitigation Measures GRW-1A and GRW-1B (Alternative D): ***Prepare and Implement a Stormwater Pollution Prevention Plan, Prepare and Implement a Construction Groundwater Management Plan.*** Refer to Mitigation Measures GRW-1A and GRW-1B (Alternative A). The same measures would be used here. Impacts would be **less than significant** after mitigation.

Impact GRW-2 (Alternative D): *Long-term Changes in Groundwater Quality.* Refer to Impact GRW-2 (Alternative A). Potential effects of Alternative D would be the same as potential effects of Alternative A. Conversion of previously irrigated agricultural lands into floodplain areas would reduce new sources of nutrients and pesticides that could influence groundwater quality locally. These effects would be **beneficial**.

Impact GRW-3 (Alternative D): *Changes in Groundwater Levels.* Modeling results indicate the potential presence of shallow groundwater levels above the thresholds of 5- and 7-feet below ground surface along the edges of the San Joaquin River. Based on the model results, the area outside of the levee alignments with simulated depth to water less than 5 feet is 330 acres and an additional 70 acres have simulated depth of 5 to 7 feet below ground surface. Figure 13-10 shows the potential areas with depths to groundwater less than monitoring thresholds for the wide floodplain alternatives, including Alternative D. Similar to Alternative A, the model shows that infiltration and seepage from the river migrates primarily downward to the water table. The mound of groundwater produced from this infiltration and seepage does not extend more than 1,000 feet laterally from the river.

Through levee design features and seepage management measures, as described in Impact GRW-2 (Alternative A), potential adverse effects of an elevated groundwater level, such as waterlogging of crops and mobilizing of salts in the soil profile, would be avoided or substantially reduced in Alternative D. Compared to the No-Action Alternative, seepage impacts to adjacent lands under Alternative D are likely to be similar to or less than seepage impacts to adjacent lands under the No-Action Alternative.

Compared to existing conditions, groundwater levels would likely increase in areas immediately adjacent to San Joaquin River levees, however, seepage impacts would be avoided or substantially reduced by implementation of Project design features and seepage management measures. Therefore, these impacts would be **less than significant**.

Impact GRW-4 (Alternative D): *Changes in Groundwater Recharge*. Refer to Impact GRW-4 (Alternative A). Potential effects of Alternative D would be similar to potential effects of Alternative A, with the exception that the floodplain would have an average width of approximately 4,200 feet. Increasing inundation areas and inundation frequencies would facilitate groundwater infiltration causing a beneficial effect on groundwater recharge.

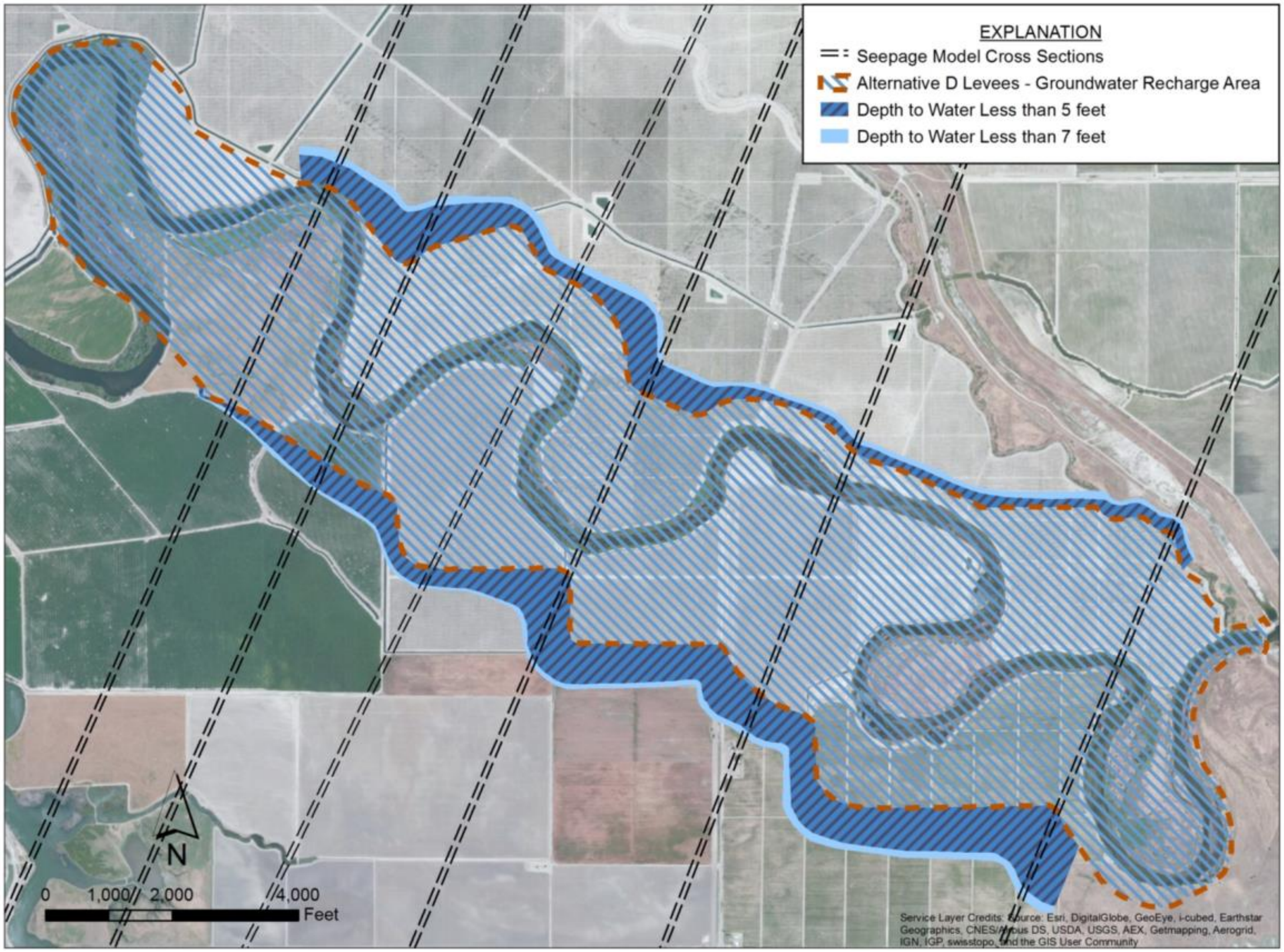


Figure 13-10.
Potential Areas with Depths to Groundwater Less than Monitoring Thresholds – Alternative D